Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 57 Issue: 03:2024
DOI: 10.5281/zenodo.10799477

ANALYSIS OF FLUORIDE CONCENTRATION IN GROUND WATER OF CHARKHI DADRI TEHSIL AND BAUND KALAN SUB-TEHSIL OF CHARKHI DADRI DISTRICT, HARYANA, INDIA

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Abstract

Human health is influenced by fluoride deficiency or abundance in the environment. Fluorosis is estimated to affect approximately two hundred million population in twenty-five countries worldwide. The two most populated nations in the world, China and India, are most severely impacted. India is home to nearly 12 million of the world's 85 million tonnes of fluoride deposits. The fact that fluorosis is endemic in 17 Indian states is not surprising. Rajasthan, Tamil Nadu, Andhra Pradesh, Haryana, Uttar Pradesh, Punjab and Gujarat have been the hardest-hit states. The purpose of the present research was to assess the fluoride concentration of the groundwater in the Charkhi Dadri Tehsil and Baund Kalan Sub Tehsil of Haryana, which serves as the area's main supply of drinking water. One hundred eight groundwater samples were collected either from handpumps, tubewells or wells and were tested for fluoride content. Fluoride concentrations ranged from 0.01mg/l to 8mg/l in Charkhi Dadri Tehsil, and the fluoride concentration of 9 out of 21 villages was found to be under 0.7mg/ltr. In Baund Sub-tehsil of Charkhi Dadri District in Haryana. All 21 villages in Baund Sub-Tehsil of Charkhi Dadri district had fluoride levels that were below the WHO's highest admissible limit of 1.5 mg/l; however, Fluoride levels in 11 out of 87 villages/towns exceeded the permissible level in Charkhi Dadri Tehsil of Charkhi Dadri District, making them inadequate for drinking. Furthermore, skeletal and dental fluorosis is at an alarming level among nearby residents in these areas. The principal origins of fluoride in groundwater are assumed to be the abundance of fluoride-bearing minerals in the host rock, along with chemical characteristics like dissociation, dissolution and decomposition, in addition to their interaction with water. The suggested disciplinary measures to minimize fluoride contamination include dilution by blending, effective irrigation practices, artificial recharge and construction of well.

Keywords: Fluoride, Ground water, Fluorosis, Baund Kalan, Charkhi Dadri, Haryana, India.

INTRODUCTION

The usage of groundwater as a source of water for drinking, having high levels of arsenic and fluoride, has been universally acknowledged as being India's two major public health concerns. Fluorine being the most electronegative of all chemicals, it is never found in elemental form in nature. When mixed chemically into fluorides, it is the 17th most abundant element in the crust of the planet, making up around 0.06 to 0.09 percent of the crust (WHO, 1994).

According to a World Health Organization assessment, drinking water with fluoride at low concentrations (0.5–1 mg/L) is advantageous, notably for increasing enamel calcification and guarding teeth against tooth decay (Shi et al 2022).

Due to the increased fluoride consumption brought on by drinking tainted subsurface water, fluoride contamination in subsurface water is a serious issue for several countries throughout the globe (Abdolmajid., 2021).

Fluoride in excess in drinking water is a problem for people in more than 35 countries worldwide. Groundwater fluoridation and the associated health risks are a global issue, with the worst-affected nations being those in Africa, the USA, Australia, China, and India.

Beside India and China, other nations with major fluoride pollution issues include Ethiopia, Kenya, Ghana, and Tanzania. Another research looked at the Telangana area in India, where granite rocks are one of the main sources of fluoride. N. Adimalla, H. Qian, and others, (2019) Fluoride-contaminated places provide a possible health danger, and their negative effects are especially felt in semi-arid parts of countries like Central Mongolia (I.S. Peretyazhko, E.A. Savina et al 2020).

In 2020, M.T. Alarcon-Herrea, et al Nearly 20 percent of Ghana's drinking water wells are fluoride-prone. The study included a number of age groups linked to fluoride exposure.

Several studies on fluoride contamination are being conducted in Haryana, which suggests that the groundwater there contains these chemicals. In a study on groundwater in Manesar, Haryana, (Priyanka Yadav et al2021) found contamination from nitrate and fluoride in groundwater samples from some villages.

Fluoride concentration in the samples ranged from 0.3 to 0.16 mg/l, according to research done by Sucheta Yadav et al in 2019 on the presence of fluoride in groundwater samples from District Mahendergarh.

Bhupinder Singh et al 2017 conducted research in the villages of Pataudi, Harsaru and Haily Mandi, and found fluoride concentrations ranging from 1.68 0.35 to 3.22 1.18 to 1.78 0.12 mg/l. JP Yadav, S Lata, et al (2003) conducted a study on urine fluoride samples and drinking water in the children of Jhajjar District, Haryana, and discovered that the concentration of fluoride ranged from 1.48 to 2.14 mg/l. Meenakshi et al (2003) conducted research on the Jind District's ground water and noted a variation in fluoride levels (0.3 to 6.9 mg/l).

Children are at higher risk for health problems as a result of drinking water that is tainted with fluoride and nitrate, according to a study conducted in the Panipat District of Haryana (Lakhvinder Kaur et al 2020).

In 2009, VK Garg et al conducted a study of a similar nature on the groundwater of South Western Haryana in Bhiwani District. He studied fluoride and reported (86.0 mg/l) fluoride concentration from one of the villages under his study, Motipura village, having highest concentration of fluoride to date.

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A research conducted in the Jhajjar District indicates a rise in fluoride and nitrate in the district's groundwater (Ruchi Gupta and Anil Kumar Mishra 2018). Another investigation on the groundwater in Hisar District, Haryana, found that the content of fluoride in the groundwater samples ranged from 0.24 to 9.27 mg/l.

According to a recent study on the Markanda River in Kurukshetra District, well water in Haryana contains a high quantity of nitrate i.e. 99.5 mg/l (Rakesh K Watts et al2019). All of these studies conducted in Haryana showed the presence of Fluoride.

The goal of the present research work was to examine groundwater quality in Baund Sub-Tehsil and Charkhi Dadri Tehsil of Charkhi Dadri district of Haryana, India, with a special emphasis on fluoride concentrations.

GUIDELINES

There should be no more than 1.5 milligrammes of fluoride per litre (mg/L) in public water supplies, as recommended by the WHO. In drinking water, the Indian government reduced the maximum permissible quantity of fluoride from 1.5- 1.0 mg/L on the grounds that lower levels are better. (BIS, 2012).

This is because many people in rural India do not get enough nutrients (such as antioxidants, vitamins E and C, and calcium) and extreme climatic conditions over there. Therefore, in drinking water, the optimal fluoride concentration is 1.0mg/ L in India, whereas 1.5 mg/L is the highest concentration as per the recommendations.

Site Specifications and Sampling

Charkhi Dadri is the 22nd district in the northern Indian state of Haryana, with 2 Tehsils (Charkhi Dadri and Badhra) and 1 sub-tehsil (Baund Kalan). It is located between 76.2653° E longitude and 28.5921° N latitude and has 1370.11sq.km. Land area (Fig. 1).

The distance between the district and New Delhi is 112.6 kilometers, while the distance between the district and Chandigarh is 295. There are around 5,02,276 people living in its 172 villages, and its literacy rate is 67.04 percent.

The semi-arid climate may be attributed to its location on the edges of the Aravalli Hills Ranges. 25 °C is the average temperature, although summer highs may reach 47 °C and winter lows can fall to 2 °C. The months of July and August account for almost 85% of the yearly average rainfall, reaching 483 mm.

Trees, for example, Neem, Peepal, Sheesham, Shami tree, catechu, and others, are typical of the xerophytic vegetation that covers much of the area. Many people in the countryside make their income from farming and livestock farming.

Sorghum, cotton, and Pearl millet are the primary Kharif crops, whereas gram, mustard, and wheat are the primary Rabi crops.

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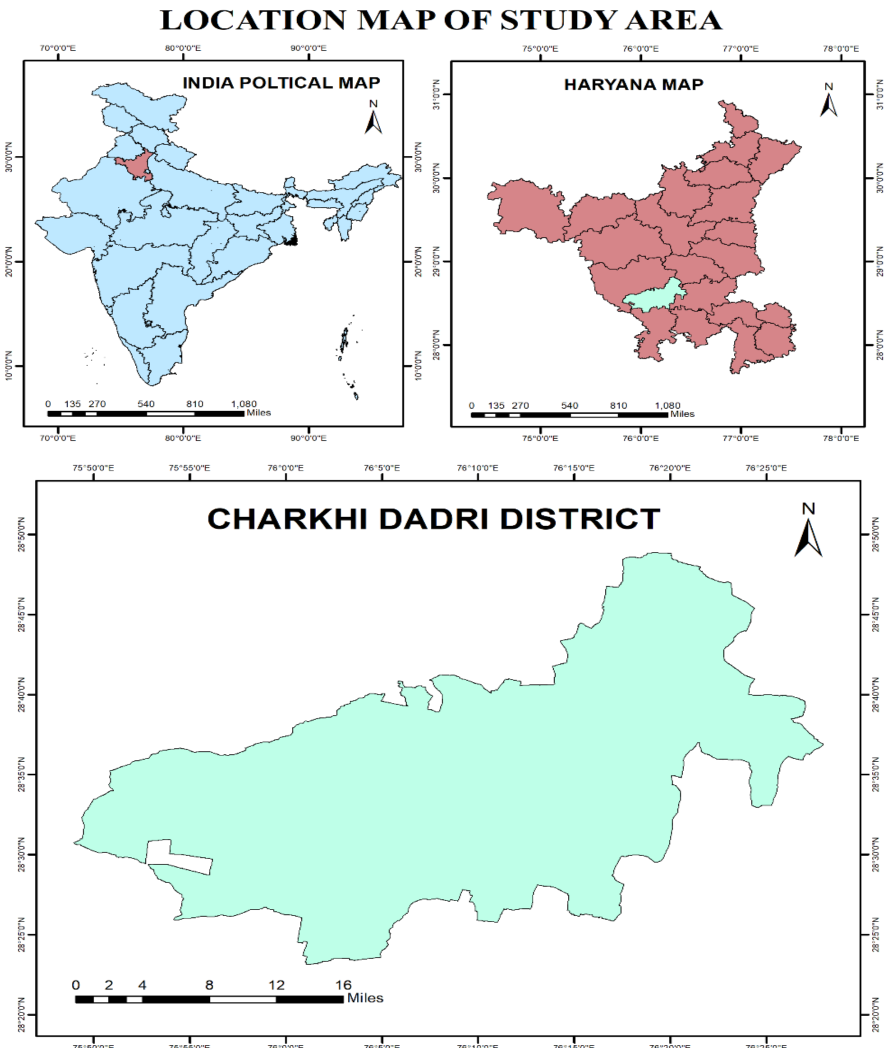
MAP of site area



WATER SAMPLES AND METHODOLOGY

From 108 villages and towns in the Charkhi Dadri area of Haryana, groundwater samples were taken in pre-cleaned plastic bottles while taking the necessary safety steps (Brown et al 1974). Using a fluoride ion selective electrode, the fluoride content in the water was measured potentiometrically (APHA, 2012). In drinking water, Fluoride concentrations may be measured with this technique between 0.01-1mg/ltr. The Cole-Parmer fluoride electrode has been linked to an electrometer for analysis. A sodium fluoride stock solution (100mg/l) produced standard fluoride solutions (0.1 to 10 mg/l). In this procedure, 10 ml of material was combined with 1 ml of TISAB II. The work was carried out at Baba Mastnath University, Asthal Bohar, Rohtak, Haryana, in the month of April 2023.

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RESULT AND DISCUSSION

Fluoride Distribution in Charkhi Dadri Tehsil: In groundwater, fluoride concentrations were measured in 87 towns/ villages in Haryana's Charkhi Dadri district. An overview of the local fluoride distribution is shown in Tables 1 to 5. Fluoride concentrations were found to range from 0.01 mg/ltr. to 8mg/ltr. The current investigation found that 76 out of 87 villages or towns had fluoride concentration in groundwater within 1.5mg/ltr.; the maximum permissible limit recommended by the World Health Organization. Fluoride concentrations in 11 out of 87 villages/towns exceeded the permissible level in Charkhi Dadri Tehsil of Charkhi Dadri District, making them unfit for drinking. Groundwater at 11 test locations (12.64 percent) was found to be inappropriate for drinking purposes according to the intended and highest allowed level for fluoride in water as specified by the WHO (1996) or the Bureau of Indian Standards (2012).

Table 1: Fluoride Conc. in Groundwater Samples in Charkhi Dadri Tehsil

Fluoride Conc. in Groundwater Samples in Charkhi Dadri Tehsil				
Sr. No.	**Block**	**Name of Village**	**Source of Water**	**Reading (mg/ltr.)**
1	Dadri	Akhtiyarpura	Tubewell	0.09
2	Dadri	Asawari	Tubewell	0.04
3	Dadri	Atela kalan	Tubewell	0.07
4	Dadri	Atela Khurd	Well	0.09
5	Dadri	Atela Naya	Tubewell	0.04
6	Dadri	Badal	Tubewell	0.05
7	Dadri	Badhwana	Tubewell	0.01
8	Dadri	Balali	Tubewell	1.50
9	Dadri	Balkara	Hand Pump	0.08
10	Dadri	Balrod	Hand Pump	0.08
11	Dadri	Barsana	Tubewell	0.07
12	Dadri	Bhagwi	Tubewell	0.02
13	Dadri	Bhairwi	Tubewell	0.08
14	Dadri	Bigowa	Tubewell	0.02
15	Dadri	Bijna	Tubewell	0.03
16	Dadri	Birhi Kalan	Tubewell	0.03
17	Dadri	Birhi Khurd	Well	1.60
18	Dadri	Chandeni	Tubewell	1.10
19	Dadri	Chang Road	Tubewell	0.05
20	Dadri	Charkhi	Tubewell	0.07
21	Dadri	Chapaar	Tubewell	0.03
22	Dadri	Chirya	Tubewell	0.80
23	Dadri	Dadhi Bana	Tubewell	0.08
24	Dadri	Dadhi Chillar	Tubewell	0.06
25	Dadri	Dadri	Tubewell	0.09
26	Dadri	Datoli	Tubewell	0.90
27	Dadri	Dhani Phogat	Hand Pump	5.00
28	Dadri	Dhoka Dina	Tubewell	0.05
29	Dadri	Dhoka Hariya	Tubewell	0.02
30	Dadri	Dhoka Moji	Tubewell	0.07
31	Dadri	Dhoki	Tubewell	0.07
32	Dadri	Dudhwa	Tubewell	0.08

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33	Dadri	Fatehgarh	Well	0.01
34	Dadri	Ghasola	Tubewell	2.80
35	Dadri	Ghikara	Hand Pump	0.03
36	Dadri	Gokal	Tubewell	4.30
37	Dadri	Gothra	Tubewell	0.07
38	Dadri	Imlota	Hand Pump	0.18
39	Dadri	Jaishree	Tubewell	0.01
40	Dadri	Jawa	Tubewell	0.03
41	Dadri	Jhojhu Kalan	Tubewell	0.01
42	Dadri	Jhojhu Khurd	Tubewell	0.01
43	Dadri	Kalali	Tubewell	6.00
44	Dadri	Kaliyana	Tubewell	8.00
45	Dadri	Kamod	Tubewell	0.03
46	Dadri	Kanheti	Tubewell	0.35
47	Dadri	Kapuri	Tubewell	2.00
48	Dadri	Kheri Battar	Tubewell	1.50
49	Dadri	Kheri Bura	Tubewell	1.20
50	Dadri	Loharwara	Tubewell	0.03
51	Dadri	Mai Kalan	Tubewell	0.01
52	Dadri	Mai Khurd	Tubewell	0.09
53	Dadri	Makrana	Tubewell	0.03
54	Dadri	Makrani	Tubewell	0.01
55	Dadri	Mandola	Tubewell	0.05
56	Dadri	Mankawas	Tubewell	0.01
57	Dadri	Merha	Tubewell	0.07
58	Dadri	Mandoli	Tubewell	0.02
59	Dadri	Mehrana	Tubewell	0.04
60	Dadri	Misri	Hand Pump	0.06
61	Dadri	Mori	Tubewell	0.01
62	Dadri	Morwala	Tubewell	1.00
63	Dadri	Neemli	Tubewell	0.05
64	Dadri	Naurangawas Jattan	Tubewell	0.09
65	Dadri	Naurangawas Rajputana	Tubewell	0.03
66	Dadri	Noswa	Tubewell	0.06
67	Dadri	Paintawas Kalan	Hand Pump	0.07
68	Dadri	Paintawas Khurd	Tubewell	0.09
69	Dadri	Palri	Tubewell	0.01
70	Dadri	Pandwan	Tubewell	0.04
71	Dadri	Patuwas	Tubewell	0.05
72	Dadri	Ramalwas	Tubewell	0.01
73	Dadri	Rambas	Tubewell	2.00
74	Dadri	Ramnagar Kapoori	Hand Pump	0.06
75	Dadri	Rasiwas	Tubewell	0.03
76	Dadri	Rawaldhi	Hand Pump	0.08
77	Dadri	Rudrol	Tubewell	7.20
78	Dadri	Sahuwas	Hand Pump	4.80
79	Dadri	Samaspur	Hand Pump	1.20
80	Dadri	Santokhpura	Tubewell	0.05
81	Dadri	Santor	Tubewell	0.30
82	Dadri	Sarangpur	Hand Pump	0.30

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83	Dadri	Sarupgarh	Hand Pump	0.16
84	Dadri	Siswala	Tubewell	1.20
85	Dadri	Tikan Kalan	Hand Pump	5.60
86	Dadri	Tiwala	Tubewell	0.03
87	Dadri	Uun Mutsil Baund Kalan	Tubewell	0.02

Table 2: Fluoride Conc. in Groundwater Samples in Charkhi Dadri Tehsil

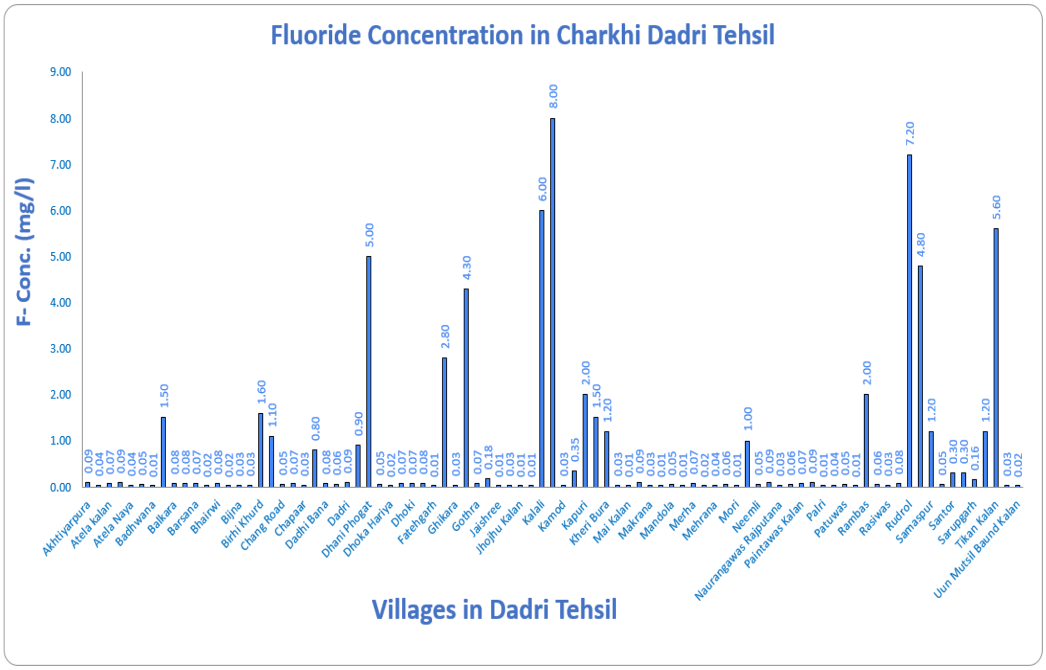

Table 3: Fluoride Conc. in Groundwater Samples in Charkhi Dadri Tehsil

Fluoride Distribution of Charkhi Dadri Tehsil of Haryana		
Reading (mg/ltr.)	No. of Villages	Name of Villages
0.01 to 1.50	76	Akhtiyarpura, Asawari, Atela kalan, Atela Khurd, Atela Naya, Badal, Badhwana, Balali, Balkara, Balrod, Barsana, Bhagwi, Bhairwi, Bigowa, Bijna, Birhi Kalan, Chandeni, Chang Road, Charkhi, Chapaar, Chirya, Dadhi Bana, Dadhi Chillar, Dadri, Datoli, Dhoka Dina, Dhoka Hariya, Dhoka Moji, Dhoki, Dudhwa, Fatehgarh, Ghikara, Gothra, Imlota, Jaishree, Jawa, Jhojhu Kalan, Jhojhu Khurd, Kamod, Kanheti, Kheri Battar, Loharwara, Mai Kalan, Mai Khurd, Makrana, Makrani, Mandola, Mankawas, Merha, Mandoli, Mehrana, Misri, Mori, Morwala, Neemli, Naurangawas Jattan, Naurangawas Rajputana, Noswa, Paintawas Kalan, Paintawas Khurd, Palri, Pandwan, Patuwas, Ramalwas, Ramnagar Kapoori, Rasiwas, Rawaldhi, Samaspur, Santokhpura, Santor, Sarangpur, Sarupgarh, Tiwala, Siswala, Uun Mutsil, Baund Kalan
1.51 to 3.00	4	Birhi Khurd, Ghasola, Kapuri, Rambas
3.01 to 4.50	1	Gokal
4.51 to 6.00	4	Dhani Phogat, Kalali, Sahuwas, Tikan Kalan
6.01 and above	2	Kaliyana, Rudrol

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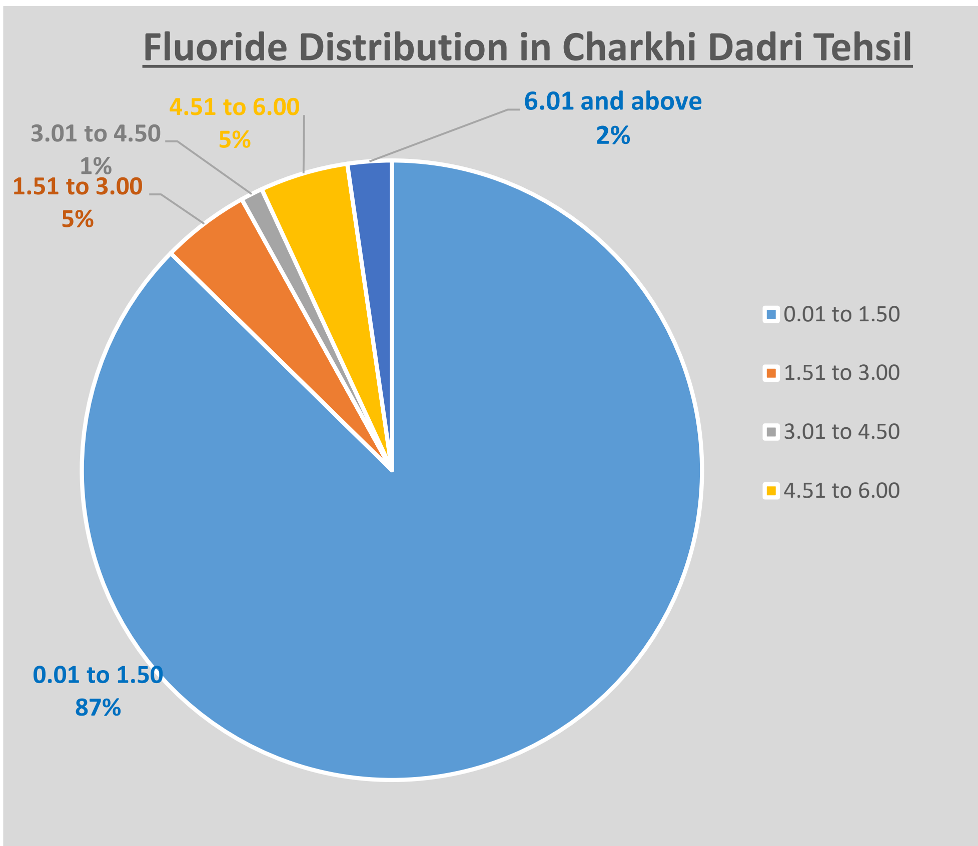
Table 4: Fluoride Conc. in Groundwater Samples in Charkhi Dadri Tehsil

Abstract of Fluoride Distribution of Charkhi Dadri Tehsil of Haryana		
Type of Reading	**Reading (mg/ltr.)**	**Name of Villages**
Minimum	0.01	Badhwana, Fatehgarh, Jaishree, Jhojhu Kalan, Jhojhu Khurd, Mai Kalan, Makrani, Mankawas, Mori, Palri, Ramalwas
Maximum	8	Kaliyana

Table 5: Fluoride Conc. in Groundwater Samples in Charkhi Dadri Tehsil



Fluoride Distribution in Baund Tehsil:

In groundwater, fluoride concentrations were measured in 21 towns/ villages in Haryana's Charkhi Dadri district. An overview of the local fluoride distribution is provided in Tables 6 and 7. Fluoride concentrations were found to range from 0.01 mg/ltr. To 1.5mg/ltr.

The present survey found that all of the 21 villages/towns (100 percent) had fluoride concentration in groundwater within 1.5mg/ltr. (The maximum permissible limit prescribed by the WHO); making them fit for drinking.

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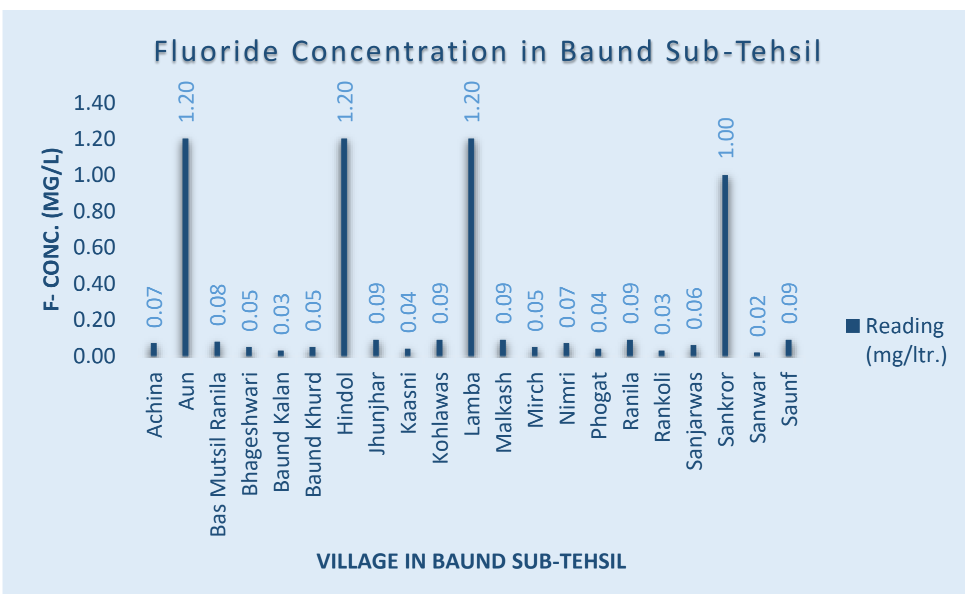
DOI: 10.5281/zenodo.10799477

Table- 6 & 7

Table 6: Fluoride Conc. In Groundwater Samples in Baund Sub-Tehsil

Fluoride Conc. in Groundwater Samples in Baund Sub-Tehsil				
Sr. No.	**Block**	**Name of Village**	**Source of Water**	**Reading (mg/ltr.)**
1	Baund	Achina	Tubewell	0.07
2	Baund	Aun	Hand Pump	1.20
3	Baund	Bas Mutsil Ranila	Well	0.08
4	Baund	Bhageshwari	Tubewell	0.05
5	Baund	Baund Kalan	Tubewell	0.03
6	Baund	Baund Khurd	Hand Pump	0.05
7	Baund	Hindol	Well	1.20
8	Baund	Jhunjhar	Well	0.09
9	Baund	Kaasni	Hand Pump	0.04
10	Baund	Kohlawas	Hand Pump	0.09
11	Baund	Lamba	Tubewell	1.20
12	Baund	Malkash	Hand Pump	0.09
13	Baund	Mirch	Hand Pump	0.05
14	Baund	Nimri	Tubewell	0.07
15	Baund	Phogat	Well	0.04
16	Baund	Ranila	Hand Pump	0.09
17	Baund	Rankoli	Tubewell	0.03
18	Baund	Sanjarwas	Hand Pump	0.06
19	Baund	Sankror	Well	1.00
20	Baund	Sanwar	Hand Pump	0.02
21	Baund	Saunf	Hand Pump	0.09

Table-7: fluoride conc. In groundwater samples in baund sub-tehsil



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PREVENTION

There is substantial evidence that fluorosis has harmed younger children and newborns, and the elderly. Developing a thorough plan to address this problem requires the immediate participation of medical and social professionals. It not only causes harm to a person's health but also makes them both culturally and socially disabled.

Significant research on fluorosis treatment has been conducted all over the world. Unfortunately, the findings indicated that fluorosis's effects are irreversible. Consequently, protecting the purity of water supplies is important since it may head off many issues before they ever start. As a result, fluoride poisoning may be prevented or mitigated by -

- The supply of defluoridated drinking water.
- Educating the public about the risks of fluoride pollution and the need to reduce exposure through water and food sources.

a) Altering one's eating habits

Defluoridating water supplies are not enough to reduce fluoride levels to a safe level. For the residual fluoride in the body to have no hazardous consequences, extra measures must be taken. Modifying the population's diet and eating habits to work with the existing social structure and food supply may achieve this goal. The primary goal should be to:

- Limit the consumption of fluoride-containing foods;
- Avoid the use of fluoride-containing cosmetics.
- Use vitamin C, calcium, as well as protein-rich foods.

There are some evidences that vitamin C may potentially serve as a preventive. Accordingly, it seems that improving the nutritional health of a population, especially children, is a successful treatment for fluorosis.

b) Water collection (alternative water source)

The effects of fluoride are not limited to humans. For this reason, it is recommended to give fluoride-free water to the animals. Due to the high cost and lack of practicality, water harvesting is the only real option for ensuring that animals have access to defluoridated drinking water.

The goal of water harvesting systems should be to offer non-fluoridated water to both humans and animals. Water collected during rainfalls is a great option since it does not contain fluoride and may be used for animals.

c) Artificial recharge

As a result, enhancing the product's quality at its origin would reduce problems and provide consumers with a better choice. Given the location and climate, it seems that artificial recharge by redirecting rainwater into the aquifer is the best option for improving water quality. A possible solution to the problem of excessive fluoride in groundwater is artificial recharge. Water with a greater fluoride concentration may be added to low-fluoride borewell water (0.5 mg/L). Clay, marble, and serpentine are all easily accessible locally and may be utilized to lower fluoride concentrations in water in places with high fluoride concentrations.

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Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 57 Issue: 03:2024
DOI: 10.5281/zenodo.10799477

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