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Status of Fluoride in Groundwaters of Haryana: A Review

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ABSTRACT

An overview of the fluoride levels in India's Haryana state's groundwater is given in this review. In many areas of Haryana, fluoride poisoning in groundwater is a major worry that could be dangerous to the public's health. The goal of this review is to gather and evaluate the current research on Haryana's groundwater fluoride levels, sources of contamination, and effects on human health. The aquifer's geological makeup, industrial effluents, and agricultural practices are the main causes of fluoride pollution in groundwater. In the southern and western parts of Haryana, where groundwater is predominantly used for drinking and irrigation, fluoride pollution is more common. The review's conclusion highlights the urgent requirement for efficient steps to reduce fluoride pollution in Haryana's groundwater. To protect the population's health, it is essential to regularly evaluate fluoride levels, put in place the proper treatment technologies, and raise knowledge of the dangers of fluoridation.

Key words: *Fluoride, Groundwater, Haryana, Contamination, Permissible limits*

Introduction

Groundwater is one of the active participants of the nature's hydrologic cycle also known as water cycle in common language. It has been widely considered as one of the most critical and vulnerable available resource provided by nature to flourish life on earth (Vörösmarty *et al*., 2000; Aeschbach-Hertig and Gleeson, 2012). The past few decades have witnessed a surpulus rise rates of dropping of aquifer water levels, drying up of wetlands due to increasing land temperature, seawater intrusion, and deterioration and degradation of water quality due to various environmental factors (Kinzelbach *et al*., 2003; Reichard and Johnson, 2005; Famiglietti and Rodell, 2013). Along with this, researches are going on groundwater which has led to an increase in coverage of a variety of topics which are related to phenomenon of geochemical as well as hydrological process of the groundwater (Wang and Cheng, 2000, El-fiky, 2010), interactions of particles, molecules and certain compounds among groundwater, surface-water, usage of land resource and climatic changes (Sophocleous, 2002, Xi *et al*., 2009, Wang and Hejazi, 2011), the hydro-geochemical attributes and water contamination (Chae *et al*., 2009, Alam *et al*., 2002), techniques for assessment as well as remodeling of groundwater (Brunner *et al*., 2006), and polices for the management of groundwater (Aeschbach-Hertig and Gleeson, 2012; Choi *et al*., 2013).

For satisfying the water needs of different industries, residential consumption, and agriculture, groundwater is a crucial resource. Groundwater is an essential component of maintaining the livelihoods and general well-being of the people living in the northern Indian state of Haryana. However, the presence of high levels of fluoride threatens the quality of the groundwater in Haryana. Groundwater fluoridation has become a serious problem, endangering the health of those who depend on it for their daily water needs. Rocks, minerals, and soil all naturally contain fluoride, a mineral that is necessary in small amounts. Through a process known as leaching, when water percolates through the earth and dissolves minerals containing fluoride, it can get into the groundwater. One of the main causes of fluoride contamination in Haryana is the aquifer's geological nature (Yadav and Yadav, 2019). Rock formations with fluoride-rich minerals are frequently found in areas with high groundwater fluoride levels. In addition to coming from natural sources, fluoride contamination of groundwater can also come from human activity including industrial discharges and agricultural operations. Fluorosis of the teeth and the skeleton has been related to excessive drinking of water contaminated with fluoride (Central Ground Water Board, 2018).

General description of Haryana: It is placed in the northern section of the country India. It is between 27°39' to 30°35' N latitude and between 74°28' and 77°36' E longitude. The whole geographical region of the state is 4.42 m ha, which is 1.4% of the geographical region of the country. The altitude of Haryana varies between 700 and 3600 feet (200 metres to 1200 metres) above sea level. It has 6 administrative divisions, 22 districts, 72 sub-divisions, 93 revenue tehsils, 50 sub-tehsils, 140 community development blocks, 154 cities and towns, 7,356 villages, and 6,222 villages panchayats.

The state has natural geographical boundaries of the Shiwalik hills in the north, the Yamuna River in the east and the Ghaggar River in the north. In the south Aravalli hills define the natural boundary which runs through southern Delhi and Gurgaon district. In the west of the state lies the Thar Desert of Rajasthan. The state is bounded by Uttar Pradesh and Delhi in the east, Punjab in the north, Himachal Pradesh in the northeast and Rajasthan in the south and west.

Haryana being located in the interior of Indian sub-continent is mostly warm and semi-arid climatic conditions. It is southwesterly monsoon winds that bring here over 75 percent of total annual rainfall from month of July to September. From October to the end of June next the weather remains almost dry excepting for few showers received from western disturbances. The average rainfall of the state is 560 mm which varies from less than 300 mm in south-western parts to over 1000 mm in the hilly tracks of northeast. The state is chronically deficit in water resources. So it has subtropical continental monsoon climate having seasonal rhythm and great annual range of temperature. The distribution of soils in Haryana reflects complexity. A major part of the state is covered by loamy soils, known as bangar soils which covers the northern and central part of the it. Silty loam soils (khaddar soil) are found along the course of Yamuna River. Clayey silts are known as bet, found along the courses of Ghaggar and Markanda seasonal streams. The extreme western part of the state is mostly covered by sandy to loamy sand soils. The sandy loam soils belt covers the western and southern districts.

Fluoride pollution and its sources in environment

Fluoride is released into the environment naturally through processes like weathering and erosion. Fluoride can be leached and carried into water bodies, including groundwater sources, when rocks and soil that contain fluoride minerals experience natural degradation as a result of rainfall, wind, and temperature changes. Additionally, when domestic sewage is released into the environment without sufficient treatment, it may contaminate neighbouring water sources, including groundwater. Improper sewage treatment and septic tank systems can also contribute to fluoride pollution (Giri and Singh, 2015).

To determine the fluoride levels in the groundwater across various areas in Haryana, numerous monitoring studies have been carried out. These investigations were significant in finding places with high fluoride concentrations and in providing helpful information for determining the scope of the issue. In these monitoring investigations, fluoride concentrations in groundwater samples were assessed using both field surveys and laboratory analyses. Commonly, groundwater samples are gathered from several wells, hand pumps, and tube wells spread throughout Haryana. The fluoride content of the samples is then precisely measured through analysis utilizing the right analytical procedures (Chakraborty *et al*., 2019).

These monitoring studies have also given important information about the temporal and geographic variations in fluoride levels. The seasonal variations in fluoride concentrations in groundwater, which can be impacted by elements including rainfall patterns and agricultural operations, have been better

Table 1. Fluoride content reported in various districts of Haryana.

S. No.	District studied	No. of samples	Findings (F- Conc.)	Method Used	Author
1	Ambala	19	1.04-3.624 mg/l	-	Gupta *et al.*, 2009
2		15	0.6-2.0 mg/l	Alizarin Spectro-Photometer	Singh *et al.*, 2010
3		10	0.22-0.77 mg/l	Spectro-Photometer	Oberoi and Gupta, 2010
4		6	0.14-0.90 mg/l	-	Rout and Sharma, 2011
5		30	0.14-1.65 m/l	Spectro-Photometer	Ravish *et al.*, 2019
6	Bhiwani	275	08-7.1 mg/l	Ion-electrode Method	Garg *et al.* 2008
7		19	0-1.9 mg/l	Ion-electrode Method	Kumari Savita *et al.* 2020
8		6	Upto 18.5 mg/l	-	Ali *et al.*, 2018
9	Charkhi Dadri	-	3.6 mg/l	-	Garg *et al.*, 2008
10	Faridabad	25	0.04-1.49 ppm	-	Kaushik *et al.*, 2004
11		78	0.26-8.0 ppm	-	Susheela *et al.*, 1993
12	Fatehabad	150	0.03-1.9 ppm	-	Seema *et al.* 2004
13		20	0 - 2 mg/l	Field Water Testing Kit	Bisht *et al.*, 2018
14	Gurugram	30	0.95-55.2 mg/l	Ion-selective electrode method	Singh *et al.*, 2007
15		97	0.0-6.4 mg/l	-	Manjeet *et al.*, 2014
16		30	-	-	Yadav and Pandey, 2021
17		-	0.9-2.42 mg/l	-	Mor *et al.*, 2008
18	Hisar	22	0.1-3.4 ppm	-	Kaushik *et al.*, 2002
19		127	0.03-16.6 mg/l	Ion-selective electrode method	Khalwal and Garg, 2006
20		126	0.04-16.5 ppm	-	Ravindra and Garg, 2006
21		40	0.5-5.0 mg/l	-	Kumar *et al.*, 2015
22		50	0.5-2.98 mg/l	Spectro-Photometer	Kumar and Sharma, 2017
23	Jhajjar	231	0.05-44 mg/l	Spectro-Photometer	Yadav and Lata, 2003
24		149	0.1-4.3 mg/l	Ion-selective electrode method	Md. Arif *et al.*, 2015
25		-	1.63-3.33 mg/l	Spectro-Photometer	S. Kumar *et al.* 2016
26		20	0.2-1.9 mg/l	Ion-selective electrode method	Gupta and Misra, 2018
27	Jind	23	0-2 mg/l	SPANDS Method	Singh *et al.*, 2013
28		60	0.03-6.9 mg/l	-	Meenakshi *et al.*, 2004
29		24	0.42-2.0 ppm	-	Mor *et al.*, 2003
30	Kaithal	12	1.01-1.9 mg/l	Spectro-Photometer	Gurcharann Das, 2016
31	Karnal	50	0.53 - 4.50 mg/l-	-	Malik and Kavita, 2022
32	Kurukshetra	8	0 - 1 mg/l	-	Kumar *et al.*, 2021
33	Mahendragarh	355	0.3-16 mg/l	Ion-selective electrode method	Yadav *et al.*, 2019
34	Nuh	1166	0.08-1 mg/l	Ion-selective electrode method	Sharma *et al.*, 2020
35	Palwal	58	0.1-1.7 mg/l	ALPA	Ahmad *et al.*, 2020
36	Panchkula	10	1.3-2.13 mg/l	-	Deshwal and Gupta, 2010
37		5	0.5-1.5 mg/l	Field water testing	Kumar *et al.*, 2021
38	Panipat	41	0.24-9.27 mg/l	-	Bishnoi and Arora, 2007
39		42	0.5-5.95 mg/l	-	Kaur *et al.*, 2020
40		40	0.24-1.76 mg/l	Ion-selective electrode method	Singh and Singh, 2021
41	Rewari	-	4.8 mg/l	-	Fawell *et al.*, 2006
42	Rohtak	63	0.034-2.09 mg/l	-	Bishnoi and Arora, 2007
43	Sirsa	40	0.25-5.02 mg/l	-	Rani and Kaushik,2013
44		26	0.45-7.20 ppm	SPADANS method	Pareek *et al.*, 2020
45		52	0.90-34.50 mg/l	SPADANS method	Singh and Bansal, 2012
46		20	0.4-2.6 ppm	-	Kumar and Jain, 2017
47	Sonipat	10	0.88-1.71 mg/l	Analytical Spectrophotometer	Punia *et al.*, 2018
48	Yamunanagar	-	0.14-1.65 mg/l	-	Ravish *et al.*, 2020

understood.

Conclusion

In conclusion, Haryana's groundwater contamination with fluoride poses a serious threat to the general public's health. Effective steps are required to lessen the effects of the rising fluoride levels, which are mostly linked to natural geological processes and human activity. The main health consequences of chronic consumption of fluoride-contaminated water are dental and skeletal fluorosis. Therefore, it is essential to execute comprehensive programs that prioritize monitoring fluoride levels, choosing appropriate treatment options, and increasing public awareness of the hazards and precautions.

Authorities in Haryana must keep up their efforts to combat fluoride contamination of groundwater going forward. This entails improving monitoring programs to precisely gauge fluoride levels, putting in place suitable treatment methods, and giving access to clean drinking water sources a top priority. For fluoride removal projects to be successfully implemented and managed, cooperation between government agencies, water supply authorities, research institutes, and local populations is crucial. Haryana may lessen the negative health consequences of fluoride contamination and make sure that its citizens have access to safe and clean drinking water by taking a multi-pronged strategy that incorporates technical solutions, governmental measures, and community involvement.

Conflict of Interest

The authors declare that no conflict of interest exists.

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