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Water Quality of Jaipur District In Respect Of Fluoride Content and Its Impact on Health

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ABSTRACT:
Water is the most precious and prerequisite element for Sustaining life on the Earth. Safe water is essential for the Human and all the living organisms. The present paper, " Water Quality Of Jaipur with respect to Flouride content and its impact on health is an endeavor to study thedistribution of Flouride and its quantity, and Sources in Jaipur district along with its impact on health,. The study is based upon primary data(water samples) and secondary data,datatabulation and analysis .Excessive amount of Flouride causes many health problems and the only solution is deflouridation process through Precipitation, Absorption and Electrochemical methods and membrane technique which have been discussed in this paper .

KEY WORDS: *Flouride, flourosis.*

I. INTRODUCTION:

"Water is the abject necessity for any kind of life to exist", Atharva Veda.

This is a fundamental truth that water is the most basic element required to survive on earth, not only for humans but all the biotic and abiotic components of earth. Though mother earth has plenty of water but sad part is that it is entirely not usable because of its salinity. Earth surface has 71% of water, which forms the basis for all forms of life existing on earth.Out of this 71% ,96.5% of it is present in seas and oceans,1.7% in groundwater and glaciers also as the ice caps of Antarctica and Greenland.A small fraction of 0.001% is present in the air as vapor, clouds (formed of ice and liquid water suspended in air), and precipitation. Only 2.5% of this water is freshwater, and 98.8% of that water is in ice and groundwater. Less than 0.3% of all freshwater is in rivers, lakes, and the atmosphere, and an even smaller amount of the Earth's freshwater (0.003%) is contained within biological bodies and manufactured products. Earth's interior comprises of a larger quantity of water. So among all these the amount of portable or usable water is just 2.8%.

Safe drinking water is essential to humans and other life forms even though it provides no calories or organic nutrients. Access to safe drinking water has improved over the last decades in almost every part of the world, but approximately one billion people still lack access to safe water and over 2.5 billion are devoid of adequate sanitation. However, it has been estimated by some observers that by 2025 water based vulnerability will be faced by more than half of worlds populations.

Since in many tropical countries especially in India groundwater is the major source of portable water. Therefore, with quantity, quality of water is also important. But what basically the quality of groundwater is and what are the factors that influence water quality? The answer to this query is that, the quality of ground water in some parts of the country, particularly shallow ground water, is changing as a result of human activities. While other important factor is that Water is a solvent and dissolves minerals from the rocks with which it comes in contact. Ground water gets its tangy taste because of the dissolved minerals namely sodium, calcium, magnesium, potassium, chloride, bicarbonate, sulfate etc. And gases in it without which the water would taste flat. In water chemistry, these substancesare called common constitute.

But excess amount of these constituents can be degrading too. Water is considered soft if it contains 0 to 60 mg/L of hardness, moderately hard from 61 to 120 mg/L, hard between 121 and 180 mg/L, and very hard if more than 180 mg/L. Very hard water and extremely soft water are not desirable for many domestic uses as hard watercreates scaly deposit on the inside of pipes, boilers, and tanks. Extremely soft water corrodes metals, although it is used for laundering, dishwashing, and bathing. Hard water can be softened at a fairly reasonable cost

Other than hardness other major problem of water quality is fluoride content of water. Though fluoride is important for tooth enamel and other enzymatic functions but excess of it can be fatal too. It is seen that exposure to high fluorinated water has led to many ill effects on dental enamel, endocrine effects, osteoporosis, skeleton fluorosis, gastrointestinal effects and many more.

Present paper mainly aims to study the distribution of fluoride rocks, there amount of mixing with groundwater and harmful effects seen on humans.

PROBLEM:

Fluoride is the simplest anion of fluorine which is the ninth element of the periodic table. Nevertheless, its application and biological significances were known only in the decade of 1920's. it is the lightest member of the halogen family and most electronegative among all chemical elements. Fluorine has both chemical qualities and physiological properties, which are of great significance to human health. The 'fluoride ion' is more chemically active than any other elemental ion. There it plays an important role in human physiology. Its presence in low concentration stimulates the enzymes function normally but high concentration can be fatal.

Fluoride is consumed by humans in number of ways like use of glass ceramic utensils in which fluoride is being used, eating food products which have been grown using fluoride fertilizer and the most important ,direct source is drinking ground water rich in fluoride content, which is a common problem of rural India.

SOURCES OF FLUORIDE IN WATER

Sources of fluoride in water

Fluoride always occurs in combined form of minerals as fluoride. It is highly reactive and represents about 0.06 to 0.09% of earth crust (WHO, report 1994).

Small amount:Fruits ,Vegetables,Cereals
Large amount ;Sea foods and tea leaves

The presence of fluoride in ground water is a natural phenomenon and is mainly influenced by geological structure, as the fluoride minerals are almost soluble in water.Fluoride always occurs in combined form of minerals asfluoride. It is highly reactive and represents about 0.06 to0.09% of earth crust (WHO, report 1994).Sources of Fluoride

The presence of fluoride in ground water can be attributed togeological reasons. (Ashok Kumar Yadav et al. 2009) Fluoride exists naturally in water sources. Generally, most groundwatersources have higher fluoride concentrations than surface water.The main source of fluoride in groundwater is basically from therocks minerals shown in Table-1. These are commonlyassociated with the country rocks through which the groundwater percolates under variable temperature conditions.Besides these minerals, alkali rocks, hydrothermal solutions,phosphate fertilizers, burning of coal, manufacturing process ofaluminium, steel and bricks may also contribute to higherconcentration of fluoride in groundwater.The concentration of fluoride in water sources depends uponvarious factors like source of water, solvent action of water onthe rocks and soil of earth's crust, porosity of the rocks or soilthrough which water passes, the speed with which water flows,the temperature of the interaction of the rock and water, thehydrogen and calcium ion concentration, amount of annualrainfall etc. (Ashok Kumar Yadav et al. 2009; Tailor & Chandel2010; Singh P et al. 2011; Hussian et al. 2012;). The main sources of fluoride in ground waterare basically from minerals and rocks. Their concentration isgiven in table.1.

Table 1: concentration of fluoride in various rocks.

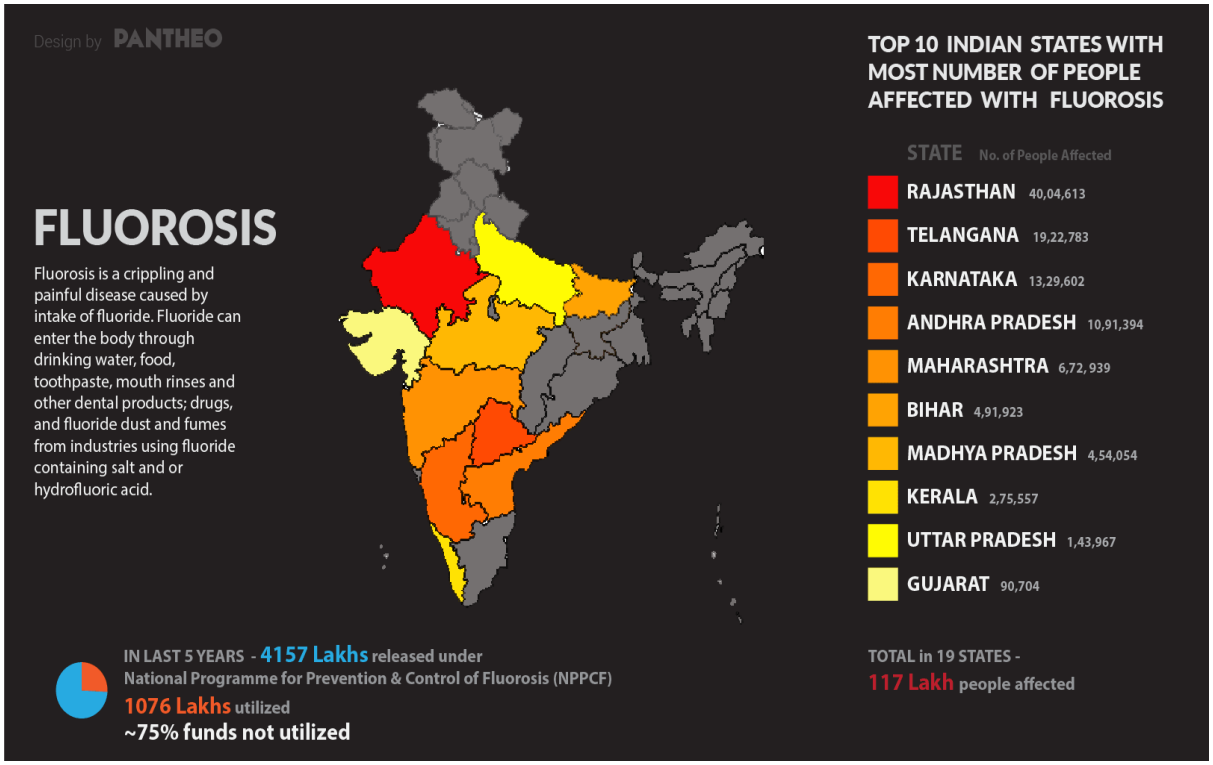
Rocks	Fluoride range (in ppm)	Average (in ppm)
Basalt	20-1060	360
Granite and gneisses	20-2700	870
Shales and clay	10-7600	800
Lime stones	0-1200	220
Sandstones	10-880	180
Phosphorite	2400-41500	31000

The weathering and leaching process, mainly bymoving and percolating water, play an important role in the incidence of fluoride in ground water. The fluoride rich minerals,which are present in rocks and soil, when come in contact withwater of high alkalinity they release fluoride into ground waterthrough hydrolysis replacing hydroxyl (OH) ion (Hussain andSharma) and this process of mixing or reaching continuously increases concentration of fluoride in groundwater. The permissible limit of drinking fluoride concentrated wateraccording to WHO 1984 and Indian Standard drinking water specification 1991 the maximum permissible limit of fluoride is1.5 ppm and highest limit is 1.0 ppm Millions of people largely depend on groundwater with fluoride concentrations above the World Health Organization (WHO) guidelines.

WORLD SCENARIO OF FLORIDE IN WATER: There are >20 developed and developing nations with fluoride endemic areas. High fluoride concentrations in groundwater are found in the USA, Africa, Asia, China, India, Ghana, Kenya, Tanzania and Sri Lanka and Australia besides other countries in different continents.

INDIAN SCENARIO OF FLORIDE IN WATER:Fluorosis is wide spread in many parts of India with an estimated 66.62 million people being exposed to fluorosis in various endemic regions with more than half a million people already crippled by it. At least 20 states in India namely - Andhra Pradesh, Rajasthan, Gujarat (70-100% districts are affected), Bihar, Punjab, Haryana, Karnataka, Maharashtra, Madhya Pradesh, Tamil Nadu, Uttar Pradesh and some parts of Delhi (40-70% districts are affected), Assam, Kerala, Orissa, West Bengal, Jammu & Kashmir (10-40% districts are affected) and even Uttranchal, Jharkhand and Chattisgarh are identified as significantly affected. The water in 25 districts of Gujarat state- Ahmedabad, Amreli, Anand, Banaskantha, Bhuj, Bharuch, Bhavnagar,Dahod, Gandhinagar, Godhra, Jamnagar, Junagadh, Kachchh, Kheda, Mehsana,Narmada, Navsari, Patan, Porbandar, Rajkot, Sabarkantha, Surat, Surendranagar,Vadodara and Valsad was found to contain fluoride in excess of ICMR and as well as WHO permissible standards. India thus has been facing another water-related public health problem after arsenic. Fluoride enters human body through a variety of sources viz., water, food, air, medicaments and cosmetics. The chief natural source of fluoride in soil is the parent rock itself and virtually, all foodstuffs contain at least trace amounts of fluoride as it is ubiquitous in the environment.

Fluorosis can manifest as skeletal and non-skeletal ailments.



Rajasthan Scenario Of Flouride in Water :

The geographical and geological setup of Rajasthan has led to my water related issues The semi-arid and arid conditions of Rajasthan has led to decline in water resources and also discharged the ground water table. As a result of this people are now forced to drink fluorinated water above the permissible limit (0.5-1.0 mg/l).

The study made by Rajasthan Voluntary Health Association in 1994 has showed that total number of villages having fluoride problem in Rajasthan is 2433 covering nearly 2.6 million Population.

The Survey of India indicates that the degree of fluoride problem is very serious in seven districts namely (Ajmer, Bhliwara, Nagaur, Dausa, Jaipur, Tonk, Jalore.).

As mentioned above that Jaipur district faces high fluoride problem ,present paper is related to that and its impact on Health of the population of Jaipur.

II. OBJECTIVES OF THE STUDY: -

The principle objectives of this study are enumerated below. These objectives are related to the present status of water quality and its environmental impacts. The objectives are:

1. To examine the fluoride content in ground water through collected samples.
2. To determine the relationship between mean annual rainfall and fluoride concentration hence mean annual rainfall is also taken into consideration.
3. To study the effects of fluorinated water on inhabitants.
4. To analyze the drinking water fluoride level in the rural areas of district Jaipur.
5. To estimate the pH, electrical conductance, total hardness, total alkalinity, chloride, calcium and magnesium.
6. To observe the relationship between fluoride and other analysed parameters.

III. RESEARCH METHODOLOGY

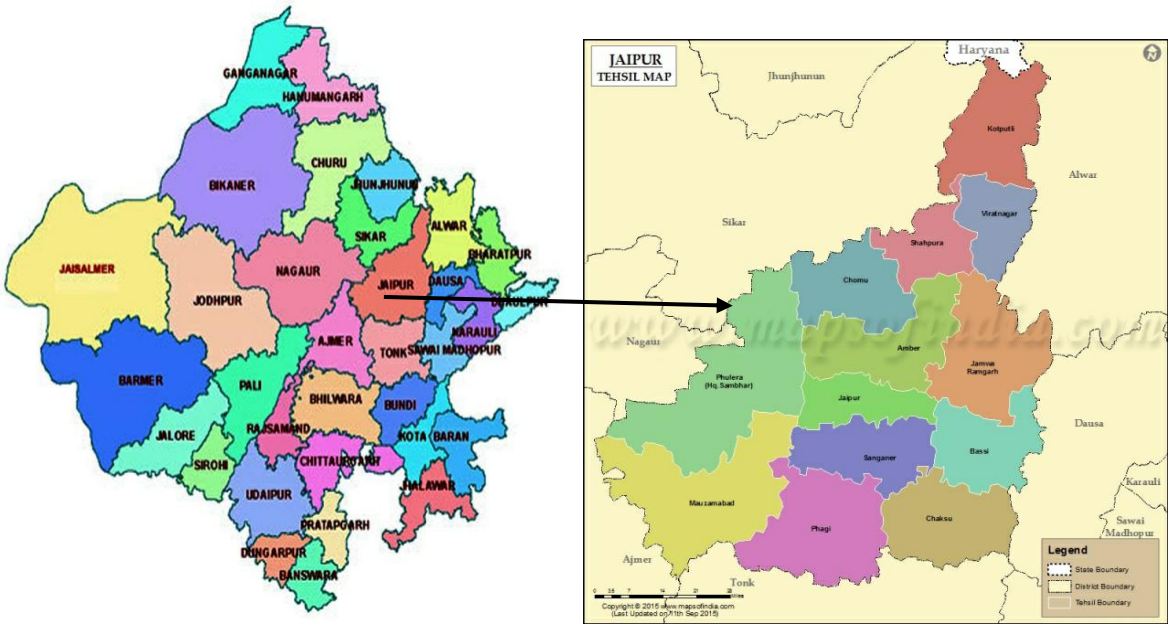
The data has been collected both from primary and secondary sources. Secondary sources include published and unpublished reports of government and other agencies like WHO, Survey of Indian, health departments etc. Primary sources include field sample collection of groundwater from sources.

Five water samples were collected from different areas and sources. That is samples were collected from villages such as Amarpura, Chimanpura, Nathwala,

STUDY AREA

Jaipur the capital city of Rajasthan, is considered as one of the first planned city of India. It lies in the semi-arid region of Rajasthan and on the foothills of Aravalli series. Jaipur is a popular tourist destination in India and serves as a gateway to other tourist destinations in Rajasthan. The city has very well defined architectural structure with was planned by raja Jai Singh under the guidance of Vidhyadhar Bhattacharya. During the rule of Sawai Ram Singh I, the city was painted pink to welcome the Prince of Wales, later Edward VII, in 1876.Many of the avenues remained painted in pink, giving Jaipur a distinctive appearance and the title Pink city.

Jaipur district, covering geographical area of 11,061.44 sq. km and extending between north latitudes 26o 25' and 27o 51' and east longitudes 74o 55' and 76o 15' forms east-central part of the Rajasthan State. For administrative convenience, the district is divided into 16 tehsils and 15 blocks. Two blocks namely Pawta and Jalsuare formed in 2014. Since the ground water resources estimation and notification is as per 13 blocks formation.Jaipur District is sharing border with Ajmer District to the west, Alwar District to the East, Dausa District to the East, Nagaur District to the west, Sikar District to the North, Tonk District to the South. Jaipur District occupies an area of approximately 11152 square kilometres. It sins the 509 meters to 264 meters' elevation range. This District belongs to Hindi Belt .



DEMOGRAPHY:

According to the 2011 census Jaipur district has a population of 6,663,971, roughly equal to the nation of Libya or the US state of Washington. This gives it a ranking of 10th in India (out of a total of 640). The district has a population density of 598 inhabitants per square kilometre (1,550/sq mi). Its population growth rate over the decade 2001-2011 was 26.91%. Jaipur has a sex ratio of 909 females for every 1000 males, and a literacy rate of 76.44%.Below table throws light on the ever increasing population of Jaipur districtin 2011and in 2020-2021(estimated)

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Jaipur district population

S.No	TEHSIL	POPULATION 2020	POPULATION 2021
1	Chomu	383,159	395009
2	Phulera	430,782	444105
3	Chaksu	216925	223634
4	Amer	438445	452005
5	Kotputli	400858	413256

6	**Viratnagar**	**161104**	**166087**
7	**Shahpura**	**200809**	**207020**
8	**JamwaRamgarh**	**294139**	**303236**
9	**Mauzamabad**	**206626**	**213016**
10	**Phagi**	**185,392**	**191126**
11	**Sanganer**	**940605**	**969696**
12	**Bassi**	**275086**	**283594**
13	**Jaipur**	**7440132**	**6626178**

Data source : Google India growing and Census(Note: population of 2020-21 is expected population.)

CLIMATE

Jaipur is the capital city of the desert state of Rajasthan. Owing to its location in the semi-arid Thar Desert in Rajasthan, the climate in Jaipur is varies from extremely hot in the summer months to pleasant and cool weather in the winter months. The location of Rajasthan in the northwestern part of India has resulted in the extremities of climate in the state. The state of Rajasthan mainly has dry and hot climate. Rajasthan climate can divided into summer, post monsoon, monsoon and winter. The temperature during the summer months varies between 32degree C to 45degree C. It is Hot in summer. Jaipur District summer highest day temperature is in between 26 °C to 44 °C. Average temperatures of January is 17 °C, February is 18 °C, March is 25 °C, April is 30 °C, May is 34 °C .The monsoon season starts at the end of June and remains till mid-September. There is great variability in rainfall too. The average annual rainfall of Jaipur district is 492 mm with CV 39%.

GROUND WATER SCENERIO

- **HYDROGEOLOGY**

Jaipur mainly lies on hard rocks which is covered by quaternary fluvial and Aeolian deposits composed of sand, silt, clay, gravel and kankar. Southern and south western part of district has less thickness of alluvial i.e.dudu, Mozamabad, Phagi, Chaksu areas etc. In the northern
part of the district, altitude of bedrock ranges from 426.72 m above mean sea level at Kairi (Shahpura) to 337 m above mean sea level at Kotputliindicating northerly sloping bed rock. part of the district, altitude of bedrock ranges from 426.72 m above mean sea level at Kairi (Shahpura) to 337 m above mean sea level at Kotputliindicating northerly sloping bed rock.

Unconsolidated Quaternary formations and consolidated formations of Bhilwara and Delhi Super Groups and also post Delhi Granites occurs in ground water of the district. In greater part of the district, alluvial deposits comprising of mainly fine sand and silt serve as potential aquifers in addition to gravel zones as encountered at Sanganeir, Ambabari and Shahpura. Groundwater occurs at shallow depths near water table condition and at depths under semi confined conditions. Movement of groundwater in this hard rock is controlled by size, continuity and interconnectivity of weathered and fractured parts at other secondary deposits. The geology of the region is responsible for the fluoride content in underground water of Jaipur district.

Drainage:

The rivers namely Banganga, Bandi, Dhund, Mendha, Mashi, SotaandSabi and their tributaries drain most the area of the Jaipur district. Sota and Sabi rivers in the northern part of district flow northeasterly while southwesterly flowing Banganga river passes through Shahpura, BairathandJamwaRamgarh blocks and contribute water to the famous Ramgarh lake. Mendha River in northwest portion of the district merges with famous Sambhar Lake whereas Mashi river in the southwestern part flows easterly.

IV. RESULT & DISCUSSION:

From the Tehsils of Jaipur District sample sites weretaken. Codes of sampling were given and after testing the following results of water samples were obtained.

Table 1: Fluoride concentration in Different samples (Jaipur, Rajasthan, India)

Sample collection in sterile 1 Litre bottle and analysis fluoride content as per Indian Standard

S.No.	Sampling Site	Code of Sampling Site	Fluoride (mg/L)
1.	Bassi	F1	2.03
2.	Chakbassi	F2	1.4
3.	Jhar	F3	3.20
4.	Basnkho	F 4	0.89
5.	Khatipura	F 5	1.25
6.	Luniyawaas	F 6	2.28
7.	Jaamdoli	F 7	3.21
8.	Padlimeena	F 8	3.58
9.	Kho nagroiyaan	F 9	4.59
10.	Agra road	F 10	4.55
11.	Goner road	F 11	3.28
12.	Shri ramchandrapura	F 12	6.58
13.	Sanganer	F 13	8.89
14.	Sanganer teshsil	F 14	9.58
15.	Durgapura	F 15	5.20
16.	Gopalpura	F 16	2.05
17.	Bagru	F 17	6.58
18.	Mahala	F 18	6.24
19.	Ajmer road	F 19	5.21
20.	Bhankrota	F 20	3.25
21.	Mansarovar 1	F 21	6.58
22.	Mansarovar 2	F 22	5.89
23.	Mansarovar3	F 23	9.58
24.	Mansarovar 4	F 24	2.65
25.	Mansarovar 5	F 25	8.59
26.	Jhotwara	F 26	8.56
27.	VKI area 1	F 27	6.59
28.	VKI area 2	F 28	6.88
29.	Murlipura	F 29	6.25
30.	Kalwar	F 30	5.25
31.	Chomu	F 31	3.02
32.	Kaladera	F 32	1.02
33.	Rampura	F 33	1.06
34.	Dabri	F 34	1.08
35.	Amer	F 35	2.03
36.	Delhi road	F 36	1.25

Sanganer tehsil and Mansarovar 3 has more than 9 mg/l of floride ,Mansarovar 5,Jhotwara, Sanganer had 8 mg/l.SriRamchandrapura,Bagru,Mahala,VKI area1,VKI2,Murlipura,Mansarovar1 had more than 6Mg/l,Kalwar,Mansarovar 2,Kalwar has more than 5mg/l of fluoride in water ,the residents of these areas of Jaipur district are more prone to health problems related to floride .Occurrence of high fluoride in ground water in the district is a matter of great concern. Fluoride concentration in the district ranges from 0.29 mg/litre to 4.8 mg/litre at. About 29% of ground water samples collected for chemical analysis have shown fluoride value beyond maximum permissible limit of 1.5 mg/litre. Around 64% and 7% of samples have Fluoride content within the desirable (1mg/litre) and maximum permissible limits respectively. Dudu, Sambhar, Phagi, Chaksu, Sanganer, Jothwara and JamwaRamgarh blocks are the worst affected blocks with Fluoride contamination.from the above table it is clear that out of 36 sample sites only 7 had fluoride below 1.5mg/l.

V. CONCLUSION:

From the above table it is clear that the Fluoride content is more in most of the areas of Jaipur district from where the sample of ground water was collected and tested and this has impact both on the environment and the health of the people of Jaipur district which is as follows:

Fluoride content effect on environment:

Even low concentrations of fluorine can obstruct the growth in plants which are sensitive to fluorine exposure. The higher F enrichment/translocation in leafy vegetables can be attributed to the increased rate of metabolism (and/or photosynthesis rate) in leafy shoots in comparison to seeds/grains or other storage organs (tubers).Higher metabolic activity can be associated with higher intake ofwater resulting in increased F concentrations in leafyshoots/vegetables.Too much fluoride, weather taken in form the soil by roots, or absorbed from the atmosphere by the leaves, retards the growth of plants and reduces crop yields.

Fluoride Content Effect on Human Health:

Human health is affected by the presence of fluoride in the environment. Here it was found that each ofthe selected adult family members required an average of 500 gof meal ingredient, 500 g of vegetable food, and 5 L of water perday. Positive and negative effectson human health is seen due to impact of fluoride in drinking water .Its Low levels makes the teeth resistant to decay anddevelopment of dental caries. (Tailor and Chandel, 2010) But, high intake of fluoride causes both short term and long termeffects. Acute high-level exposure to fluoride causes immediateabdominal pain, excessive salivation, nausea and vomiting.Seizures muscle spasms, muscle fibrillation and numbness ofmouth may also occur. (Singh P et al. 2011) Long term effect ofexcess fluoride through water, appear to create fluorosis whichmanifests itself as dental, skeletal and non- skeletal fluorosis.

In dental fluorosis, excessive fluoride usually causes yellowing ofteeth, white spots, and or mottling of enamel. The natural shineor lustre of the teeth disappears. In the early stage, the teethappear chalky white and then gradually become yellow, brownor black. The discoloration will be horizontally aligned on thetooth surface as “lines” away from the gums. Dental fluorosisaffects both the inner and outer surface of the teeth. Thedisease has mostly cosmetic implications and has no treatment.

Excessive fluoride intake may also result in slow, progressivecrippling scourge known as skeletal fluorosis. It causes pain and damage to bones and joints. Skeletal fluorosis affects thebones/skeleton of the body. Skeletal fluorosis can affect both young and old alike. One can have aches and pain in the joints. The joints which are normally affected by skeletal fluorosis are neck, hip, shoulder and knee, fluoride mainly gets deposited inthese joints and makes it difficult to walk and movements are painful. Rigidity or stiffness of joints also sets in. (Beg, 2009) Atadvanced stage vertebrae may fuse together and a victim may be crippled. (Meenakshi and Maheshwari, 2006)Apart from bones and teeth an excess intake of fluoride candamage or impart ill effects on other soft tissues, organs andsystems also, categorized as non-skeletal fluorosis.

A review by earlier workers reveals that almost all systems ofbody including muscle, liver, kidney, blood, cardiovascular and even reproductive, are affected. The symptoms include gastro-intestinal complaints, loss of appetite, pain in stomach,constipation followed by intermittent diarrhea.

Muscular weakness and neurological manifestations leading toexcessive thirst tendency to urinate more frequently arecommon among the afflicted individuals. Cardiac problems mayarise due to cholesterol production. Repeated abortions or stillbirth, male infertility due to sperm abnormalities are also someof the complications. (Tailor and Chandel, 2010; Singh P et al,2011).

The above health issues due to fluoride can be summarized as:

- Effect on dental enamel
- Osteoporosis
- Skeleton fluorosis
- Gastrointestinal effects
- Endocrine effects
- Immunological and lymphoreticular effects
- Neurological effects
- Reproductive effects
- Developmental effects
- Effect at molecular level
- Effect on immune system
- Fluoride as carcinogen
- Cardiovascular effects
- Deformities and crippling fluorosis

Suggestions:

The only way of getting away from fluoride impact in the areas with high limits of fluoride in Jaipur district is through deflouridation.Wide range of treatment systems are being operated for controlling excess fluoride in water.. While various defluoridation techniques have been explored, each has its limitations. Existing techniques are often too costly (because the geographic areas prone to fluorosis are among the poorest regions on the planet), ineffective or even dangerous (some of the remediation processes add other contaminants to the water) and only laboratory studies are available for some systems.The main techniques that have been, and continue to be, investigated with varying degrees of success include: adsorption, precipitation, ion exchange and membrane processes.(Krishna S Indu)

Deflouridation methods can be broadly divided into three categories

i) precipitation, ii) absorption / ion exchange or iii) electrochemical methods and membrane technique. Several reviews are available on the various deflouridation methods (Balusu, 1979; Killedar and Bhargava, 1988).

Precipitation methods involve the addition of a soluble chemical to the water, which leads to the fluoride precipitation or adsorption of fluoride on formed precipitate.

In adsorption methods the raw water is passed through the bed containing deflouridating materialAdsorption can be achieved with locally available adsorbent materials with high efficiency and cost-effectiveness. Cost-effective and locally-available herbal and indigenous products offer promising options. The process is dependent on pH and the presence of sulfate, phosphate, and bicarbonate which results in ionic competition. Disposal of fluoride-laden sludge is problematic.

Precipitation is the most well-established and most widely used method, particularly at the community level. However, it has only moderate efficiency and a high chemical dose is required. Excessive use of aluminum salts produces sludge and adverse health effects through aluminum solubility.

Ion Exchange removes fluoride up to 90-95% and retains the taste and colour of the water. Sulphates, phosphates, and bicarbonates also result in ionic competition in this method. Relatively high cost is a disadvantage and treated water sometimes has a low pH value and high levels of chloride.

Membrane processes are effective technique and do not require chemicals. It works at wide pH range This process is not suitable for water with high salinity..Thus, it is expected that utilization of variousdefluoridation technique makes the water worth drinking.Various research are going on to make the available ground water portable that is worth drinking for the increasing number of population.

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