QUALITY OF GROUND WATER AND PREVALENCE OF DENTAL FLUOROSIS IN SANGANER OF JAIPUR DISTRICT, RAJASTHAN

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Abstract

Fluoride pollution in ground and surface water of Sanganer of Jaipur district, Rajasthan, India with special reference to Dental Fluorosis has been evaluated. It has been observed that more than 90% of poor and under privileged rural people of Sanganer area is suffering from severe dental fluorosis. People of Sanganer are found well aware of the cause of dental fluorosis but they don’t have any affordable and effective means or technology to get rid of the same. To find out the causes for the prevalence of Dental Fluorosis in Sanganer of Jaipur district ground and surface water have been collected from different villages of Sanganer, different physico-chemical parameters of water samples have been analyzed and correlated with dental fluorosis.

Keywords: - Water Quality, physico-chemical parameter, fluorosis.

1. INTRODUCTION

Groundwater is particularly important as it accounts for 88% of the drinking water in rural areas[1]. As per WHO report, 20 percent of the fluoride affected villages in the whole world are in India. Groundwater has the properties of dissolving and carrying a variety of chemical and other materials in solution. Quality of groundwater depends on rock-water interaction and oxidation-reduction reactions during the percolation of water through aquifers [2,3]. Fluoride is widely distributed in soil, water, vegetation, agricultural products and sea foods. Groundwater sources such as dug wells, shallow and deep hand pumps may contain excess fluoride where minerals like fluorite, cryolite, biotites and fluoroapatite are present in rocks [4, 5, 6]. Fluoride, one of the important mineral present as dissolved state in water has different impact on human health at different concentrations. The source of fluoride in groundwater is mainly due to the fluoride bearing minerals. It is beneficial if its concentration is within the range of 0.5 to 1.5 mg/L, reduce the development of caries [7]. Concentration below 0.5 mg/L causes dental caries, especially to the children. Concentration above 1.5 mg/L leads to dental and skeletal fluorosis. Thus, the fluoride concentration in drinking water is just like two-edged knife; both at higher and lower concentration it is not safe. About 96% of the fluoride in the body is found in bones and teeth. Fluoride is also essential for normal mineralization of the bones and formation of dental enamel [8, 9, 10]. Fluorosis is a worldwide problem, several countries of world like China, West Indices, South Africa, Tanzania, Sudan, Nigeria, Kenya, Ethiopia, Sri Lanka, Spain, Italy, Holland, Ghana, Ivory Coast, Senegal, Algeria, Uganda etc facing this problem [11]. About 42.5 million people are suffering from dental fluorosis due to excess fluoride in drinking water and 2 million people are due to skeletal fluorosis found in the same country [12]. In many parts of India, high level of fluoride in groundwater is found. India is among the many countries in the world, where fluoride contaminated groundwater is creating health problems. Fluoride with high concentration in groundwater has been reported in 17 states of India [13], about 62 million people including 6 million children are affected with dental and skeletal fluorosis [14]. High groundwater fluoride concentrations associated with igneous and metamorphic rocks such as granites and gneisses have been reported from India, Pakistan, West Africa, Thailand, China, Sri Lanka and Southern Africa [15, 16]. In Indian continent, the higher concentration of fluoride in groundwater is associated with igneous and metamorphic rocks and 62 million people are at risk of developing fluorosis from drinking high fluoride.
water. The problems are most pronounced in Andhra Pradesh, Bihar, Gujarat, Rajasthan, Madhya Pradesh, Punjab, Tamil Nadu and Uttar Pradesh. Rural populations depend mainly on groundwater and major drinking water sources are worst affected. Excess fluoride concentration in drinking water has deleterious effects on human health. Awareness of excess fluoride consumption through water has been increasing in the developing nations in recent years. In the last two decades reports on the occurrence of excess fluoride in water resources in several states of India have been published by many researchers. A permissible limit of fluoride concentration in drinking water as per guidelines is up to 1.5 mg/L. Fluorosis a dreaded disease is caused in humans and animals due to intake of excess amount of fluoride in drinking water. It leads to mottled teeth, dental carries, stiffened brittle bones and joints, metabolic disorders and even paralysis in advanced stages. The only remedy for the fluorosis is to remove excess fluoride from water. Various conventional technologies like precipitation based Nalgonda technique and conventional activated alumina technique offer little hope due to inherent drawbacks like complex setup, downtime, chemical consumption, need for skilled man power and cost associated with them. Ion exchange India has to bear its pioneering experience to provide a simple, economical and effective solution to the problem of fluoride contaminated water. The INDIION fluoride removal process has been developed in mind the problems of rural India with respect to lack of awareness, low literacy level and lack of skilled operators.

2. SCOPE AND OBJECTIVE OF THE PRESENT STUDY
1. To analyze different physico-chemical parameter of ground and surface water of Sanganer of Jaipur district, Rajasthan.
2. To analyze the concentration of fluoride level in the Ground and Surface water of Sanganer of Jaipur district, Rajasthan.
3. To study the impact of fluoride level in the water on the people of Sanganer of Jaipur district, Rajasthan.
4. To recommend the remedial measures for the removal of fluoride.

3. MATERIALS AND METHODS
3.1 Geography of the study area
The Jaipur is located on 26° 46’ to 27° 01’ North latitude and 75° 31’ to 76° 57’ East longitude. It is bounded by Sikar in North, Tonk in South, Alwar, Sawaimadhopur and Dausa districts in the East and Nagaur district in the West.
1. The Sanganer is located at Jaipur district. During the rainy season the rain water collects in the river, bore well, well. The rain water is the main source of water to the river, wells and bore wells.
2. The rain water collected in the river, bore well and well is contaminated with industrial effluents which percolate in to ground water and reaches the bore well and wells. This causes the pollution of ground and well water. Contamination makes the water very hard and salty.
3. The contaminated well and ground water used for agriculture purposes affects the soil. The soil gets polluted slowly and become unfit for cultivation due to changes in the property.

4. RESULTS AND DISCUSSION
The analytical data of different physico-chemical parameter of the ground and surface water are presented in the table given below.

5. DISCUSSION
Ground water, surface water were collected from Sanganer Tehsil of Jaipur district and analyzed. Results are presented in tables followed by discussion.

5.1 Level of Fluoride
Among the different inorganic components fluoride ion was found dominant in concentration ranging from 1.2 to 6.20 mg/L in the ground and surface water of Sanganer. High fluoride ion in ground water of Sanganer conclusively justifies the impact of fluoride in the form of dental fluorosis. Prevalence of dental fluorosis is found significantly more in Sanganer area of Jaipur district.

5.2 pH
The pH of water is an important indication of its quality and it depends on the CO$_3$ equilibrium. Acid-Base reaction is important in ground and surface water and their influence on pH and on the ion chemistry. The level of pH of the water sample in the study area varies from 7.25 to 8.40. Value indicates the alkalinity of the water sample. The pH value of 7.25 to 8.40 usually indicates the presence of calcium and magnesium.

5.3 Total dissolved solids (TDS)
The major part of the TDS is consistent with HCO$_3$, SO$_4$ and Cl ions of calcium, sodium, and magnesium ions. These ions usually comprise about 90% of TDS. Hydro chemical processes, which may include movement of ground water through rocks containing soluble minerals, industrial and municipal waste disposal may cause an increase in the dissolved solids. The TDS of the water sample in the study area varies from 182 to 890 mg/L. It indicates the presence of significant amount of calcium and magnesium in the water of Sanganer.
5.4 Electrical conductivity

Electrical conductivity is a useful parameter of water quality for indicating salinity hazards. Electrical conductivity in the water samples of Sanganer varies from 480 to 1360 µmho/cm. It indicates that the salinity is more prevalent than sodality in Sanganer area of Jaipur district. It further supports the presence of significant amount of calcium and magnesium in the water samples of Sanganer of Jaipur district.

Table A.1 Water samples have been collected from the following areas

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Zone</th>
<th>Name of the location</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Sanganer North</td>
<td>Kalyanpura, Mansarover, Durgapura, Sunder nagar</td>
</tr>
<tr>
<td>S2</td>
<td>Sanganer South</td>
<td>Pratap nagar, Sitapura, Khoosar, Vidharsi, Ashawala, Goner</td>
</tr>
<tr>
<td>S3</td>
<td>Sanganer West</td>
<td>Muhana, Shikarpura, Ramjipura, Kishprpura</td>
</tr>
<tr>
<td>S4</td>
<td>Sanganer East</td>
<td>Jagatpura, Chatarpura, Shyopur, Ramnagariya</td>
</tr>
<tr>
<td>S5</td>
<td>Sanganer Center</td>
<td>Sanganer main and sanganer airport</td>
</tr>
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Table A.2 Analysis of Physico-chemical parameters

<table>
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<tr>
<th>S. No</th>
<th>Parameters</th>
<th>CPHEEO STD A</th>
<th>CPHEEO STD B</th>
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<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
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<td>Odour</td>
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<td>Color Less</td>
<td>Color Less</td>
<td>Color Less</td>
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<tr>
<td>2</td>
<td>Turbidity (NTU, Max)</td>
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<td>10</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>3</td>
<td>TDS (mg/L)</td>
<td>500</td>
<td>2000</td>
<td>487.4</td>
<td>419</td>
<td>680</td>
<td>182</td>
<td>890</td>
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<tr>
<td>4</td>
<td>EC(µmho/cm)</td>
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<tr>
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<td>pH</td>
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<td>6.5-9.2</td>
<td>7.25</td>
<td>7.30</td>
<td>8.4</td>
<td>7.62</td>
<td>7.32</td>
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<tr>
<td>7</td>
<td>Total Alkalinity</td>
<td>200</td>
<td>600</td>
<td>76</td>
<td>570</td>
<td>435</td>
<td>720</td>
<td>200</td>
</tr>
<tr>
<td>8</td>
<td>Total Hardness as CaCO3 (Mg/L)</td>
<td>200</td>
<td>600</td>
<td>125</td>
<td>938.5</td>
<td>145</td>
<td>719</td>
<td>420</td>
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<td>Calcium(mg/L)</td>
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<td>90</td>
<td>70</td>
<td>19</td>
<td>51.1</td>
<td>210</td>
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<td>10</td>
<td>Magnesium(mg/L)</td>
<td>30</td>
<td>150</td>
<td>70</td>
<td>842</td>
<td>23</td>
<td>670.2</td>
<td>230</td>
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<tr>
<td>11</td>
<td>Chloride(mg/L)</td>
<td>200</td>
<td>1000</td>
<td>109</td>
<td>337.3</td>
<td>69</td>
<td>221.2</td>
<td>270</td>
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<tr>
<td>12</td>
<td>Fluoride(mg/L)</td>
<td>1</td>
<td>1.5</td>
<td>4.60</td>
<td>4.49</td>
<td>2.90</td>
<td>6.20</td>
<td>3.2</td>
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<td>6.20</td>
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<td>13</td>
<td>Standard plate count/ml</td>
<td>-</td>
<td>400col/ml</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>14</td>
<td>Total coliform/100ml</td>
<td>-</td>
<td>10col/100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>Nature of coliform bacteria isolated</td>
<td>-</td>
<td>0/100ml</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>16</td>
<td>Faecal streptococcus</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

CPHEEO: Central Public Health Engineering and Environmental Organization
CPHEEO STD A – Acceptable limit.
CPHEEO STD B – Cause for Rejection
from 19 to 210 mg/L. The level of Mg$^{2+}$ of the water sample in the study area varies from 23 to 842 mg/L. The concentration level of Ca$^{2+}$ and Mg$^{2+}$ in water samples of Sanganer area is an important indication of its quality leading to the formation of more CaF$_2$ which again is responsible for Dental Fluorosis.

### 6. REMOVAL OF FLOURIDE FROM GROUND WATER

Analysis of water quality of Sanganer of Jaipur district and the prevalence of the dental fluorosis indicated that the removal of fluoride from water may be the best way to decrease the dental fluorosis in the Sanganer area of Jaipur district. For the removal of fluoride from the surface and ground water of Sanganer to be used for domestic purposes, neem stem charcoal in its fine powder form has been investigated as an affordable means. It has been found that neem stem charcoal significantly removes the fluoride from the ground and surface water of the Sanganer. In the investigation it has been found that it works efficiently in the pH range of surface and ground water of Sanganer. Total capacity of the neem stem charcoal in terms of the maximum absorption of fluoride ion per gram of neem stem charcoal has also been investigated. Considering different critical parameters of surface and ground water of Sanganer the removal of fluoride ion with neem stem charcoal has been optimized. The easiest way of regeneration of neem stem charcoal has been investigated. Finally how the idea can be transferred to house hold technology with low cost affordable house hold items has also been developed and the same has been demonstrated to the rural under privileged community of Sanganer. The optimum condition for the removal of fluoride from the surface and ground water of Sanganer area has been determined. Best result was obtained when 10L water (average daily family consumption for drinking) was passed through the column of transparent PVC of dia. 6.36 inches and length of 50 inches). Column was packed with sand of length 4 inches, neem stem charcoal of length 8 inches and sand of length 2 inches respectively as it is shown in Fig.A.7. Output flow rate of water was

#### Table: A-3 Fluoride ion concentration in water samples before and after passing through Neem Stem Charcoal

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Sample no.</th>
<th>Ci (mg/L)</th>
<th>Cf (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S1</td>
<td>4.60</td>
<td>0.92</td>
</tr>
<tr>
<td>2</td>
<td>S2</td>
<td>4.49</td>
<td>0.85</td>
</tr>
<tr>
<td>3</td>
<td>S3</td>
<td>2.90</td>
<td>0.68</td>
</tr>
<tr>
<td>4</td>
<td>S4</td>
<td>6.20</td>
<td>1.0</td>
</tr>
<tr>
<td>5</td>
<td>S5</td>
<td>3.2</td>
<td>0.72</td>
</tr>
</tbody>
</table>

*Ci (mg/L) - initial concentration, Cf (mg/L) - final concentration of fluoride ion in mg/L

![Fig.A.7. Defluoridation by using Neem Stem Charcoal](image_url)
maintained to 100 mL/min such that 10L water may be purified by 2h. Results and the proposed house hold technology for the removal of fluoride ion have been presented in table A-3 and Fig.A-7

7. CONCLUSION
With every authentication judiciously it is reported in the literature [25, 28, 29, 30, 31, and 32] that slight excess of fluoride causes severe Dental Fluorosis. In our survey we have found that a major part of residents of Sanganer area have been suffering from Dental Fluorosis. Under privileged community of Sanganer depends on the surface and ground water directly for drinking, washing, bathing and for other domestic purposes. Analysis of the surface and ground water of Sanganer reveals that the concentration of fluoride ranging from 1.2 mg/L to 6.2 mg/L. As per WHO, BIS and ISI the fluoride concentration in healthy drinking water should be around 0.5 mg/L. So it may be concluded that the prevalence of Dental fluorosis in Sanganer area, is due to the impact of high fluoride level in water samples. Dental surgeon also conforms by diagnosing the people of Sanganer and recommends for remedial measures to have control on the fluoride level on water to be used for different domestic purposes. The best way to remove the fluoride ion from the surface and ground water of Sanganer but it has been found from the survey that this technology is not affordable to the rural under privileged community. Neem stem charcoal has been found very effective to remove the fluoride ion from the surface and ground water of Sanganer. Technology has been found very affordable and the transfer of technology to the grass root level may be easy.

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9. REFERENCES

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