Abstract: Fluorine is the 13th most abundant naturally occurring element in the earth’s crust and is the lightest member of the halogens. It is the most electronegative and reactive of all elements and as a result, elemental fluorine doesn’t occur in nature, but found as fluoride mineral complexes. Exposure to fluoride beyond the recommended level for long duration causes fluorosis. Several physical and chemical defluoridation methods have been designed to treat high fluoride concentration in ground water. There is need to develop such methods for defluoridation which would be cost effective and bio degradable. Tulsi plant is found to detoxify water with high fluoride content and makes it safe for human consumption. As this method is found to be cost effective and bio degradable this area needs further study and research.

Introduction

The problem of high fluoride in groundwater has now become one of the most important toxicological and geo environmental issues in India. During the last three decades high fluoride concentration in water resources resulting in the disease called "Fluorosis" is being highlighted considerably throughout the world. Over the years rapid strides have been made in India to mould the availability of water to match country’s manifold potable water demand. It is a conclusive fact that concentration between 0.6 to1.2 mg/L is essential to protect teeth resulting in the disease called “Fluorosis” is being dealt. Nowadays high fluoride concentration in water resources is one of the most important toxicological and geo environmental issues in India. During the last three decades high fluoride concentration in water resources resulting in the disease called "Fluorosis" is being highlighted considerably throughout the world. Over the years rapid strides have been made in India to mould the availability of water to match country’s manifold potable water demand. It is a conclusive fact that concentration between 0.6 to1.2 mg/L is essential to protect teeth resulting in the disease called “Fluorosis” is being dealt.

Fluorosis has attained an alarming dimension all over the world. It is wide spread in certain developing countries like Kenya, China, Algeria, Argentina, Morocco, Senegal, Turkey and Thailand and also in developed countries like Japan and USA. In India, one of the serious health problems is prevalence of fluorosis. A report published by Rajiv Gandhi National Drinking Water Mission in 1983 identified 15 states including Delhi as endemic for fluorosis. Presently, 17 states which are endemic for fluorosis are: Andhra Pradesh, Karnataka, Tamil Nadu, Haryana, Maharashtra, Gujarat, Rajasthan, Kerala, J&K, Himachal Pradesh and Chandigarh states are also affected by fluorosis.

Human beings have been suffering fluorosis since ages. However, the cause of this disease is intake of high content of fluoride was ascertained only a few decades ago. Problem is increasing day by day as fluoride level is gradually getting higher than the prescribed maximum desirable limits. The fluoride level in water in India ranges from 2-29 ppm, where as the permissible level in drinking water according to WHO standard is 1.0 -1.5ppm. High incidence of endemic fluorosis in India is due to fact that large areas of the country’s water supplies are having high level of fluoride. In tropical countries, skeletal fluorosis occurs even with drinking low level of fluoride.

Epidemiological observation revealed that nutritional status might influence chronic fluoride toxicity.

People are consuming fluoride in water up to 18 mg/L. It is easily absorbed by the body from contaminated drinking water. After absorption, fluoride ion is quickly distributed throughout the body, easily crossing the membranes and going into tissues. It accumulates in body due to high reactivity of fluoride ion with calcium of teeth and bones. It forms calcium fluorophosphates (Fluorapatite) crystal and leaves unbound calcium in the same tissue, which gets calcified and in turn results in stiffness of tissues and joints. This finally leads to skeletal fluorosis in later stage. That’s why fluoride is called as bone seeking mineral and bones as sink for fluoride. About 90% of the fluoride retrieved in body is associated with calcified tissues.

Motivation

High concentration of fluoride causes various health impacts. Hence it is taken as motivation. Fluoride inhibits enzymes that breed acid-producing oral bacteria whose acid eats away tooth enamel.

This observation is valid, but some scientists now believe that the harmful impact of fluoride on other useful enzymes far outweighs the beneficial effect on caries prevention.

Fluoride ions bind with calcium ions, strengthening tooth enamel as it forms in children.

Dental fluorosis:-

Dental fluorosis is the loss of luster and shine of the dental enamel. The discoloration starts from white yellow, brown to black. Dental fluorosis is invariably seen on horizontal lines or on bands on the surface of the teeth. Fluorosis is seen as mild moderate and severe depending on the amount of fluoride ingested during the stages of formation of the teeth.

Skeletal fluorosis:-

Excessive quantity of fluoride deposited in the skeleton, which is more in cancellous bone than cortical bone. Fluoride poisoning leads to severe pain associated with rigidity and restricted movements of cervical and

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umber spine, knee and pelvic joints as well as shoulder joints. In severe cases of fluorosis, there is complete rigidity of the joints resulting in stiff spine described as “bamboo spine”, and immobile knee, pelvic and shoulder joints.

**Non-skeletal fluorosis:**

This kind of fluorosis is often overlooked due to misconception that fluoride affects only bone and teeth. Fluoride when consumed in excess can cause several other kinds of manifestations.

**Neurological:** Nervousness, depression, tingling sensation of fingers and toes, excessive thirst and tendency to urinate more for equity.

**Muscular:** Muscle weakness, stiffness, pain in muscles and loss of muscle power.

**Allergic:** Very painful skin rashes, which are perivascular inflammation prevalent in women and children, pinkish red or non-persistent oval shaped bluish-red spots on the skin.

**Gastro-intestinal:** Acute abdominal pain, diarrhea, constipation, blood in stool tenderness in stomach.

**Urinary tract:** Urine may be less in volume, red in colour and passed with itching sensation.

**Drug induced fluorosis:**

The prolonged use of drugs containing sodium fluoride is known to cause skeletal fluorosis. During 1982, two cases of drug induced skeletal fluorosis were reported from Switzerland. Patients of rheumatoid arthritis received uninterrupted and prolonged treatment with niflumic acid. The daily dose of drug administered was 3 capsules of 250 mg niflumic acid (Nifluril, UPSA Laboratories, France).

**Industrial fluorosis:**

A number of industries use hydrofluoric acid and fluoride containing salts, in the different sections of an industry for one reason or other. The industries that use fluoride are as follows.


Fluoride dust and fumes pollute the environment, inhaling the dust and fumes are as dangerous as consuming fluoride containing food, water or drugs.

<table>
<thead>
<tr>
<th>Concentration of fluoride</th>
<th>Medium</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ppm</td>
<td>Water</td>
<td>Dental caries reduction</td>
</tr>
<tr>
<td>2 ppm or &lt; 2 ppm</td>
<td>Water</td>
<td>Mottled enamel (dental fluorosis)</td>
</tr>
<tr>
<td>8 ppm</td>
<td>Water</td>
<td>10% osteosclerosis</td>
</tr>
<tr>
<td>20-80 mg/day</td>
<td>Water or food</td>
<td>Crippling skeletal fluorosis</td>
</tr>
<tr>
<td>50 ppm</td>
<td>Water or food</td>
<td>Thyroid changes</td>
</tr>
<tr>
<td>100 ppm</td>
<td>Water or food</td>
<td>Growth retardation</td>
</tr>
<tr>
<td>125 ppm</td>
<td>Water or food</td>
<td>Kidney changes</td>
</tr>
<tr>
<td>2.5-5.0 g</td>
<td>Acute dose</td>
<td>Death</td>
</tr>
</tbody>
</table>

Industrial fluorosis is a serious problem in the developed western and other industrialized countries. However, due to rapid industrialization in India, the problem of industrial fluorosis is reaching an alarming state and is compounding the problem of endemic, water and food borne fluorosis.

**STATE OF WORK**

The defluoridation methods are divided into three basic types depending upon the mode of action:

1. Based on chemical reaction with fluoride:
   Eg: Nalgonda technique

2. Based on adsorption process:
   Eg: Bone charcoal, activated alumina, plant materials, burnt clay...

3. Based on ion-exchange process:
   Eg: Anion/Cation exchange resins

**1. Nalgonda Technique:**

The Nalogonda technique (named after the village in India where the method was pioneered) employs flocculation principle 1. Nalgonda technique is a combination of several unit operations and the process involves rapid mixing, chemical interaction, flocculation, sedimentation, filtration, disinfection and sludge concentration to recover waters and aluminium salts. Alum (hydrated aluminium salts) - a coagulant commonly used for water treatment is used to flocculate fluoride ions in the water. Since the process is best carried out under alkaline conditions, lime is added. For the disinfection purpose bleaching powder is added. After thorough stirring, the chemical elements coagulate into flocks and settle down in the bottom.

**2. Activated alumina:**

Activated alumina is a granular, highly porous material consisting essentially of aluminum trihydrate. It is widely used as a commercial desiccant and in many gas drying processes.

Activated Alumina can be regenerated with HCl, H$_2$SO$_4$, Alum or NaOH. The use of NaOH needs to be followed by a neutralization to remove residual NaOH from the bed. Fluoride removal by activated alumina is strongly pH dependent. The ability of activated alumina to remove fluoride depends on other aspects of the chemistry of water as well. Such factors as hardness, silica and boron, etc., if present in water will interfere with fluoride removal and reduce the efficiency of the system.

**3. Natural adsorbents:**
Many natural adsorbents from various trees were tried as defluoridation agents. Seeds of the Drumstick tree, roots of Vetiver grass and Tamarind seeds were few among them. The seeds of the drumstick tree (Moringa oleifera) adsorb fluoride from water. Drumstick seeds act as a coagulant. They have long been a traditional method for purification of turbid water in both India and Africa. Swaminathan Research Foundation had shown drumstick seeds to have remarkable defluoridation efficiency, which was higher than that of activated alumina. But, these results were not reproducible. The roots of Vetiver grass (Vetiveria zizanoides) are another product that has traditionally been used for water purification. The roots were effective at defluoridation and could remove as much as 70% of the fluoride from a sample. The defluoridation efficiency was higher than activated alumina, and the price was comparable. But, the quantity of grass needed is so high that, a family would need to rise acres of Vetiver grass every year in order to provide enough material for defluoridation. Tamarind seeds were successfully tested for defluoridation by sorption. Since maximum defluoridation is achieved at an optimum pH of 7, post defluoridation pH adjustment is not required. Tamarind seeds, which are otherwise considered a kitchen waste, can be obtained at much cheaper price.

**DESCRIPTION AND PROPOSAL**

**Study on Tulsi:**

Tulsi is known as the “Queen of plants”. Tulsi is described as sacred and medicinal plant in ancient literature. The name Tulsi is derived from Sanskrit, which means matchless one. Tulsi is an important symbol of the Hindu religious tradition. Although the word ‘Tulsi’ gives the connotation of the incomparable one, its other name, Vishnupriya means the one that pleases Lord Vishnu. Found in most of the Indian homes and worshipped, its legend has permeated Indian ethos down the ages. Tulsi is frequently mentioned as one of the main pillars of herbal medicine. The sacred plant is described as a protector of life, preventing misery and diseases.

**Traditional uses:**

The leaves of Tulsi are most commonly used for their health benefits, although all parts of the plant, including the roots, stems, flowers and seeds, have significant and differing medicinal and religious symbolic properties. Tulsi beads, made from the woody stalks, are commonly strung in necklaces, bracelets, belts, and meditation malas or rosaries, which are believed by many to have spiritual as well as physical protection benefits. Tulsi is also known as "the elixir of life" since it promotes longevity. Different parts of plant are used in Ayurveda and Siddha systems of medicine for prevention and cure of many illnesses and everyday ailments like common cold, headache, cough, flu, earache, fever, colic pain, sore throat, bronchitis, asthma, hepatic diseases, malaria fever, as an antidote for snake bite and scorpion sting, flatulence, migraine headaches, fatigue, skin diseases, wound, insomnia, arthritis, digestive disorders, night blindness, diarrhea and influenza. The leaves are good for nerves and to sharpen memory.

Chewing of Tulsi leaves also cures ulcers and infections of mouth.

**Tulsi in modern perspectives:**

Current scientific research offers substantial evidence that Tulsi protects against and reduces stress, enhances stamina and endurance, increases the body’s efficient use of oxygen, boosts the immune system, reduces inflammation, protects against radiation damage, lessens aging factors, supports the heart, lungs and liver, has antibiotic, antiviral and antifungal properties, enhances the efficacy of many other therapeutic treatments; and provides a rich supply of antioxidants and other nutrients. Overall, Tulsi is a premier adaptogen, helping the body and mind to adapt and cope with a wide range of physical, emotional, chemical and infectious stresses, and restore disturbed physiological and psychological functions to a normal healthy state.

The general vitality enhancing and health promoting properties, in addition to Tulsi many more specific therapeutic actions, likely account for much of the exceptionally broad range of Tulsi traditional medical uses, as well as contributing to its mythological importance and religious sanctity.

Modern scientific research provides evidence that Tulsi offers the following benefits. Holistic Health Promotion, Heart and Vascular Protection, Stress Resilience, Liver Support, Energy and Performance Enhancement, Lung and Bronchial Support, Anti-Aging Effects, Antioxidant Activity, Nutrition, Nutrition, Allopathic Medicine Complement, Immunity Tune-Up, Radiation Protection, Immunity TuneUp, Anti-inflammatory Action, Antibiotic Protection, lowers blood sugar levels in diabetics and supports dental and periodontal health (and diminishes “bad breath”). Also protects against mercury poisoning speeds healing of bone fractures, reduces nausea, vomiting and cramping, and repels insects, including mosquitoes and lice. Research indicates that Tulsi has a very high safety margin with exceptionally low toxicity, providing general beneficial effects at doses without adverse reactions or other undesirable side effects.

**Proposed methodology:**

In a major relief to millions of people living in fluoride-hit areas, it has been found that the leaves and stem of Tulsi can detoxify water with high-fluoride content, and make it safe for human consumption. The quality of water one gets will be on par with the norms prescribed for fluoride content by the Bureau of Indian Standards (ISI).

Tulsi or Ocimum sanctum has natural bio-adsorbent properties i.e. the leaves and stem of this Indian herb serve as natural magnet to adsorb (attach) the fluoride molecules in water. All one has to do is to take a few leaves or stem pieces of Tulsi and dip them in a
Defluoridation of water using Tulsi as a bio-adsorbent is successfully tested process. Fresh and dried Tulsi leaves, stem pieces are the content used to remove fluoride content from water. Both boiling and shaking methods can be followed. In the boiling method, first water has to be boiled with Tulsi, and in shaking method, Tulsi has to be kept in water and glass has to be shaken gently.

“With initial fluoride concentration of 5 ppm, it was observed that maximum 94 per cent of fluoride can be removed at a dose of 75 mg of fresh basil leaves for a sample of 100 ml for a contact period of 20 minutes”.

Fresh basil stem with a dose of 100 mg/100 ml had a removal efficiency of 75 per cent, whereas for dry leaves and dry stem at a dose of 250 mg/100 ml, the removal efficiency was 78 per cent and 74 per cent respectively.

“This makes the fluoride concentration within the permissible limit of Indian standard for drinking water (IS 10500:1991, Fluoride 1.0-1.5 ppm). The efficiency of adsorption of fluoride ion was affected by pH, quantity and size of Tulsi parts used. This technique is cost effective, environment friendly and easy to understand and can be adopted in rural as well as urban background throughout the year”.

Plan of work:
First year: Collection of literature and analysis samples of water from students from their villages.
Second year: Process of defluoridation of samples collected from groups of students belonging to different villages in Nalgonda district.

CONCLUSION
Natural contamination of groundwater by fluoride causes irreparable damage to plant and human health (table-1). High oral intake of fluoride results in physiological disorders, skeletal and dental fluorosis, thyroxin changes and kidney damage in humans. High fluoride levels inhibit germination, causes ultra structural malformations, reduce photosynthetic capacities, alter membrane permeability, reduce productivity and biomass and inflict other physiological and biochemical disorders in plants. Several physical and chemical defluoridation methods have been designed to treat high fluoride waters. However ion exchange and chemical treatments are cost intensive, while physical methods suffer limitations like frequent change of defluoridant beds and inability to reduce fluoride to non-toxic levels. Biological defluoridation methods/technically design upgraded methods can serve as a best alternative to the conventional methods of defluoridation. Community should adopt such methods of defluoridation which would be cost effective and efficient. As cultivation of Tulasi is very easy, we don’t get any problem in gathering raw materials. Also it of very low cost method, biodegradable method, without leaving any harmful residues in environment, surely it is the best method to adopt and implement.

References