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Review Article

Dentistry Section

Mitigation of Fluorosis - A Review

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ABSTRACT

Fluoride is required for normal development and growth of the body. It is found in plentiful quantity in environment and fluoride content in drinking water is largest contributor to the daily fluoride intake. The behaviour of fluoride ions in the human organism can be regarded as that of "double-edged sword". Fluoride is beneficial in small amounts but toxic in large amounts. Excessive consumption of fluorides in various forms leads to development of fluorosis. Fluorosis is major health problem in 24 countries, including India, which lies in the geographical fluoride belt. Various technologies are being used to remove fluoride from water but still the problem has not been rooted out. The purpose of this paper is to review the available treatment modalities for fluorosis, available technologies for fluoride removal from water and ongoing fluorosis mitigation programs based on literature survey. Medline was the primary database used in the literature search. Other databases included: PubMed, Web of Science, Google Scholar, WHO, Ebscohost, Science Direct, Google Search Engine, etc.

Keywords: Activated alumina, Bone char, Defluoridation, Drinking water treatment, Fluorosis, Oral health

INTRODUCTION

Fluorine which has been included in the list of 14 physiologically essential elements required for normal growth and development does not exist in the elemental state in nature [1]. Its ionic form, fluoride, is found abundantly in a wide variety of minerals, including fluorspar, rock phosphate, etc [2]. Due to the universal presence of fluorides in the earth's crust, all water sources contain fluorides in varying concentrations.

The purpose of this review was to collate published material to provide readers with a single publication that describes the various techniques available for fluorosis mitigation. Medline was the primary database used in the literature search. Other databases included: PubMed, Web of Science, Google Scholar, WHO, Ebscohost, Science Direct, Google Search Engine, etc. National and State department of health websites were also searched for relevant publications. Articles were retrieved using keywords: defluoridation, fluorosis mitigation, activated alumina, defluoridator, nalgonda technique, etc.

FLUORIDE BELT

One of the environmental health issues connected with geogenic processes is excess fluoride in groundwater. Its ingestion through drinking water and food products leads to dental and skeletal fluorosis [3]. Geographical belt of high fluoride content in groundwater extends from Syria through Jordan to Kenya and another belt stretches from Turkey to China [4]. Endemic fluorosis has been reported in most of the regions of Africa and Asia with high levels of fluoride in water. Approximately, 100 million people worldwide are thought to have been suffering from fluorosis. Natural concentrations of fluoride in water as high as 2800 ppm (Lake Nakuru, in Rift valley in Kenya) have been reported [5].

In India, endemic fluorosis is considered to be a major public health problem. More than 60 million people in India drink water having more than optimal required concentration of fluoride [6]. According to the available literature, more than 15 States in India are endemic for fluorosis (fluoride level in drinking water >1.5 mg/l), and more than 60 million people in India suffer from fluorosis [4]. The most seriously affected states are Andhra Pradesh, Punjab, Haryana, Rajasthan, Gujarat, Uttar Pradesh, Tamil Nadu, Karnataka and Maharashtra [4].

FLUORIDE AS A DOUBLE EDGED SWORD

The behaviour of fluoride ions in the human organism is a classic example of double-edged sword [7]. Like many other nutrients and substances, fluoride is beneficial in small amounts but toxic in large amounts. Daily supplementation with fluoride within optimum limits is an important factor in preventing dental caries and an important mitogenic stimulus for osteoblasts as it may enhance mineral deposition in bone; but on the other hand, fluoride, above a threshold concentration, has been demonstrated to be toxic. Excessive consumption of fluorides for a long period in various forms results in deleterious effects on different tissues of the body such as teeth (dental fluorosis), bone (skeletal fluorosis) and soft tissues (non-skeletal fluorosis) [8].

AVAILABLE TREATMENT MODALITIES FOR FLUOROSIS

Discoloration of teeth is the most common reason for patients seeking treatment for fluorosed teeth. To restore the natural white creamy enamel appearance, the tooth may be bleached or can be subjected to micro-abrasion or macro-abrasion [9,10]. Crowns are preferred in cases where more than 50% of surface enamel has been lost as a result of fluorosis [9,10]. As such, there is no standard treatment for skeletal fluorosis; but it can be said to be reversible in some instances. After fluoride ingestion is stopped, existing fluoride level in the bone starts depleting and fluoride is excreted via urine. But this is a slow process and hence negligible results are seen. Also, treatments of the side effects are tough to deal with [11].

PREVENTION AND MITIGATION OF FLUOROSIS

Dental fluorosis is irreversible in nature and its treatment requires complex and expensive procedures which are time consuming and are not easily available to rural population. In case of skeletal fluorosis, there is no specific treatment. Therefore, due to lack of sustainable treatment measures for any form of fluorosis, prevention and control through interventions (provision of safe water and safe food) is said to be the best approach to mitigate fluorosis.

Drinking water standards for fluoride ion has been prescribed by various authorities [Table/Fig-1], which helps to limit the occurrence of fluorosis when followed properly.

Sr. No.	Authorities	Permissible limit of Fluoride concentration (mg/L)
1	WHO (International Standard for drinking water)	0.5
2	US Public Health Standard	0.7-1.2
3	BIS (IS 10500)	1.0-1.5
4	Indian Council of Medical Research	1.0-2.0
5	CPHEEO	1.0-1.5

[Table/Fig-1]: Drinking water standards for fluoride prescribed by various authorities [12]

There are two interventions to practice for the management of the disease. Fluorosis can be totally prevented and the individual can lead a normal, healthy life. The interventions to practice are: Provision of safe drinking water and Nutritional intervention

Provision of safe drinking water [13]:

- Locating alternative sources of safe water (Best method)
- Bringing in water from a distant, safe source
- Dual water source
- Rain water harvesting
- Removal of fluoride from water (defluoridation), using suitable techniques
- Prevention of industrial fluorosis by rigorous enforcement of procedures for minimizing industrial fluoride pollution.

Defluoridation of water:

Defluoridation is the conventional and widely tested method for supplying safe water to the fluorosis affected communities. It is defined as "the downward adjustment of level of fluoride in drinking water to the optimal level".

Defluoridation can be achieved through: (i) the treatment of water at the source (central treatment); (ii) the treatment of water at the household level (point of use treatment). Treatment at the source is the preferred method in most of the developed countries as it can be carried out on a large scale under direct supervision of skilled personals [14].

On the other hand, treatment of the water at point of use level i.e. at household level can be preferred in less developed countries. Treatment at the point of use has several advantages over treatment at community level. Only water required for cooking and drinking purposes can be treated through point of use defluoridator which will be cost effective and will create less amount of sludge as compared to community level defluoridation [14].

Defluoridation techniques can be broadly classified into following categories [13]:

1. Adsorption technique
2. Ion-exchange technique
3. Precipitation technique
4. Other techniques, which include electro chemical defluoridation and Reverse Osmosis.

1. Adsorption:

This technique functions on the adsorption of fluoride ions onto the surface of an active agent. In the adsorption method, raw water is passed through a bed containing defluoridating material. The material retains fluoride either by physical, chemical or ion exchange mechanisms. The adsorbent gets saturated after a period of operation and requires regeneration.

A. Activated Alumina:

Activated alumina (Al_2O_3), which has been in use for defluoridation since 1934, is prepared by low temperature dehydration (300-600°C) of aluminum hydroxides. The ligand exchange reaction at the surface of activated alumina is thought to be the probable mechanism of fluoride removal [14].

Handpump attached Defluoridation Units [15] and Domestic Defluoridation Units [14] have been developed in India by IIT Kanpur in collaboration with UNICEF using indigenously manufactured activated alumina. The advantages of this approach domestic defluoridation units are: a lower cost for treatment as only a limited volume of water is required (for cooking and drinking) to be treated and the lower requirement of treated water correspondingly lowers the need of chemicals and generates lower volume of sludge.

B. Bone Char [13,14]:

Bone char is ground animal bones, charred at optimum temperature (500^{0}C) to remove organics. The fluoride removal mechanism involves the replacement of carbonate of bone char by fluoride ion. Exhausted bone char is regenerated using caustic soda. Bone char has been used for defluoridation of drinking water in USA in the 1950's and 1960's. But first domestic defluoridation unit of drinking water, primarily using bone char, was developed by the Inter-country Centre for Oral Health (ICOH), Chiangmai, Dental Faculty of Chulalongkoran University, Bangkok, and the WHO in 1988 [16].

C. Calcined Clay [14,17]:

Aluminum oxide (Al_2O_3) present in the brick soil gets activated during burning and adsorbs excess amount of fluoride present in the raw drinking water. Filter media need to be replaced every three months if the fluoride content of raw water is 2.5 ppm [13]. Freshly fired brick pieces were used in Sri Lanka for the removal of fluoride in domestic defluoridation units.

D. Mud Pots [14,18]

Collection and storing of water in mud pots is an ancient method. Red soil and clay are used to prepare the mud pots. The raw pots are subjected to heat treatment as in the case of brick production. Hence, the mud pots also act as an adsorbent media. The major advantages of mud pots are they are economic and readily acceptable for the rural communities.

E. Natural Adsorbents [14]

A relatively less known approach of potential utility, particularly in third world rural communities, that has attracted the attention of researchers in recent years is plant-based (natural) defluoridation technique. The plants can be grown locally as needed and the costs for production and transportation can be relatively low. The use of plants for defluoridation might also achieve widespread acceptance and application by local communities more easily. Many natural adsorbents from various trees and animal sources have been tried as defluoridation agents. Seeds of the Drumstick [19], roots of Vetiver grass [14], Tamarind seeds [20], tea ash [21], egg shell powder [22] are few among them.

2. Ion Exchange [23]

The different ion exchange materials studied include bone, bone char, anion and cation exchange resins such as carbon, defluoron-1, defluoron-2, etc.

3. Precipitation

In this method, chemicals added to raw water cause precipitation of the fluoride salt as insoluble fluorapatite, which is separated from the water. Commonly used materials in precipitation technique are Aluminium salts (e.g. Alum), lime, Poly Aluminium Chloride, Poly Aluminium Hydroxy sulphate and Brushite [13,14].

A. Nalgonda Technique

The first community defluoridation plant for removal of fluoride from drinking water was constructed in the district of Nalgonda in Andhra Pradesh, in the town of Kathri. The technology was developed by National Environmental Engineering Research Institute (NEERI), Nagpur in 1961 [23]. Nalgonda Technique involves addition of Aluminium salts, lime and bleaching powder followed by rapid mixing, flocculation, sedimentation, filtration and disinfection. Aluminium salt may be added as aluminium sulphate (alum) or aluminium chloride or combination of these two. It is responsible for removal of fluoride from water [23].

The technique is highly versatile and has the applications like; for large communities, fill and draw technique for small communities, fill-and-Draw defluoridation plant for rural water supply, for domestic defluoridation units, etc.

B. Contact Precipitation [24]:

Contact precipitation is a recently reported technique in which fluoride is removed from water through the addition of calcium and phosphate compounds which leads to precipitation of fluoride. The water is then filtered through bone char that has been pre-saturated with fluoride. The presence of saturated bone charcoal medium acts as a catalyst for the precipitation of fluoride either as CaF_2, and/or fluorapatite. The process uses buckets, column filters or a combination of both (developed by WHO; 2006).

C. IISc Method [23]:

The Indian Institute of Science (IISc), Bangalore developed this simple defluoridation technique. The method uses magnesium oxide, calcium hydroxide and sodium bisulfate. Magnesium oxide removes dissolved fluoride ions from water samples by precipitating fluoride as insoluble magnesium fluoride;

$$MgO + H_2O \rightarrow Mg(OH)_2$$

$$2NaF + Mg(OH)_2 \rightarrow MgF_2 + 2\ NaOH$$

A simple to use domestic defluoridation unit was developed for fluoride removal based on IISc Method at Kolar, Karnataka to treat 15 litres of fluoride contaminated water.

4. Other techniques of defluoridation of water:

Reverse osmosis, electrolysis & electro dialysis and distillation are physical methods that are tested for defluoridation of water [25]. Though they are effective in removing fluoride salts from water, but there are certain procedural disadvantages that limit their usage on a large scale.

Prevention of Industrial fluoride emission [26]:

In the industrialized western world, industrial fluorosis leads to inhalation of fluoride dust or gas or fumes. Workers in industries and mining exposed to fluorides should be monitored and it should be ensured that their fluoride content of urine is below 5 PPM (Zsogon 1989). If the workers are found to be suffering from skeletal fluorosis, they should be removed from exposure to fluoride. Central Pollution Control Board, Ministry of Environment & Forest, Govt. of India (1998), has given a permissible limit of industrial emission of fluoride which is less than 25 mg/Nm^3 [27].

Nutritional Interventions [28]:

Fluorosis mitigation is mainly addressed through defluoridation of water in most of the cases. There are isolated cases where nutritional supplements can also be used as a part of curative measures. Nutritional intervention should focus on adequate intake of foods rich in calcium, vitamins C&E and antioxidants, along with consuming safe drinking water.

Along with these interventions, people residing in endemic areas should be made aware about the adverse health impacts of excessive fluoride and need to be motivated to adapt to the methods for mitigating fluorosis.

FLUOROSIS MITIGATION PROGRAMS

Various fluorosis mitigation programs have been conducted worldwide using defluoridation untis. Some of them include- 1) Defluoridation unit in Ngurdoto Village, Tanzania using Bucket Defluoridator using bone char [29]; 2) Fluorosis mitigation project in Ban Sankayom village in Thailand using bone char defluoridator [30]; 3) ICOH Mobile Bus Unit Project in Thailand [31] which emphasized on creating awareness among people regarding effects of excessive consumption of fluoride on health, helping them with on-site analysis of fluoride content of water samples and consulting them to solve the problem using possible alternatives.

In India, Government of India has set up National Drinking Water Mission to provide safe drinking water to its people and to combat fluorosis problem [32].

1. **Project SARITA (Dungarpur, Rajasthan) [32]:** A pilot project (Fluorosis Mitigation Programme by defluoridation using Nalgonda based drum sets and Activated Alumina filters along with community awareness activities) was launched by SARITA in four villages of Dungarpur district of Rajasthan under the sponsorship of UNICEF.
2. **Sachetana Plus:** Fluoride Mitigation Project [33]: BAIF Institute for Rural Development, Karnataka (BIRD-K), a nonprofit organization based in Tumkur District started a programme on fluoride mitigation through rainwater harvesting in 1996.
3. **Fluorosis mitigation project at Sonbhadra, UP [34]:** Peoples' Science Institute (PSI) in association with Banwasi Seva Ashram (BSA) began a programme of fluoride testing and fluorosis mitigation in Sonbhadra district in September 2004. Major components included health assessment, water quality monitoring, public awareness programs, nutritional interventions, etc.
4. **Fluorosis Mitigation In Nuapada District, Orissa [35]:** Peoples' Science Institute (PSI) along with Sahbhagi Vikash Abhiyan (SVA) launched a fluorosis mitigation program in four districts (Nuapada, Kalahandi, Bolangir, and Burger) of western Orissa in 2005.
5. **Fluorosis mitigation project in Dhar District, MP [36]:** WaterAid (UK), Vasudha Vikas Sansthan, Dhar and People's Science Institute, Dehradun initiated a fluorosis mitigation program in November 2008 in Dhar District, MP.
6. **Mitigation of Fluorosis in Nalgonda District Villages [37]:** Sai Oral Health Foundation assisted by the Government of Andhra Pradesh, had adopted a strategy of providing low fluoride water in affected villages (Anthampet and Batlapally) in Nalgonda district through the use of bone char based domestic defluoridators and rainwater harvesting systems.
7. **Integrated Fluorosis Mitigation, Madhya Pradesh [38]:** National Environmental Engineering Research Institute (NEERI) in association with UNICEF, Regional Medical Research Center for Tribals (ICMR) and Public Health Engineering Department, Govt. of Madhya Pradesh launched Integrated Fluorosis Mitigation project in two districts (Jhabua & Dhar) based on interventions which included water dilution and defluoridation and nutritional supplements in both schools and communities.
8. **National Rural Drinking Water Program (NRDWP) [39]:** It was launched by Govt. of India in 2009 with a goal to provide every rural person with adequate safe water for drinking, cooking and other domestic basic needs on a sustainable basis.
9. With a view to resolve the problem of water scarcity and high fluoride concentration in drinking water, the Government of Gujarat has identified a few long term schemes. Some of the schemes, based on import of surface water are Dharoi Reservoir Dependent Scheme, Sabarmati River Dependent Scheme and Narmada Canal Dependent Scheme [13].

FUTURE PERSPECTIVE

Combating fluorosis on a mass scale has remained a dream till now due to lack of massive communication programs, lack of awareness on the part of people, lack of political will, etc. Mass media or social media can play a vital role in preventing and limiting problem of fluorosis [40].

Government also has a key role to play in control of fluorosis. The Rajasthan Government has added a chapter on Fluorosis mitigation in the curriculum of Class VIII students. Government should make

way for public private partnership in the process of mitigation. One such project i.e. Hogenakkal Integrated Drinking Water Project for fluorosis mitigation has been undertaken by Govt. of Tamil Nadu, with funding from Japan Bank for International Cooperation (JBIC) using Tamil Nadu's share of Cauvery river water.

Dentists as well as public health dentists are at the center of this problem. Dentists, who come across fluorosis patients in their routine clinical practices, can educate and motivate these people to adapt to practices regarding safe drinking water. Doctors or dentists need to be involved in the sale of domestic defluoridator units. They can be provided with incentives for promotion of such units as in case of some medicines as followed by pharma companies. Public health dentists come across these patients through their routine surveys or during dental camps. They can utilize their knowledge and various education materials in educating these people and making them aware about hazards of fluorosis, emphasizing on importance of drinking safe water. Public health dentist can also help government in policy making, implementing various projects like NRHM, NRDWP, etc.

If water is seen as a major cause of fluorosis and prevention is possible, then can health insurance schemes be utilized to address this problem? The National rural health insurance programme (under NRHM) is now been implemented across the country. In that case, hospitals which are now part of this scheme would be more actively involved in Fluorosis mitigation [40].

In all, an entire package of options needs to be available locally to Fluorosis patients. Today, even for patients who can afford, there is no place they can visit for advice on the ailments and curative options. If one needs to buy a domestic filter for defluoridation, there is no such service available anywhere. What if these all are present together? i.e. medical advice as well as curative options. Such support centers should be established in the areas of concern. Even for Fluoride removal filters, such a center needs to offer maintenance on filters e.g. repair of parts, regeneration of Activated Alumina, etc. Apart from this, these support centers should be responsible in training the doctors and educating them towards proper diagnosis of Fluorosis and preventive measures. However, these ideas need to be tested on pilot scale before they can be transported over to a national level [40].

Proposed strategy:

1. Educating people regarding importance of safe drinking water and hazards of excessive fluoride in drinking water.
2. Health Education activities like health talks, lectures, health screening camps, demonstration of defluoridation techniques, etc.
3. Muti-sectoral approach: Involvement of Public health dentist along with PWD, Public Health Engineering Department, Chemists, Local Governing bodies such as municipal corporation, Water Department, etc.
4. Community participation.
5. Establishment of water fluoride testing laboratories in rural areas in chemistry laboratories of local colleges in that area.
6. Establishing of a data base on fluoride levels in drinking water for entire country.
7. Motivating people to adapt safe drinking water and food practices where needed.
8. Follow up of the services provides.

CONCLUSION

It is rightly said “Much has been done but much is left to do”. It is difficult to draw any conclusion for this multi-faceted problem of fluorosis or to propose a universally accepted strategy, which would be ‘good’ for all. Fluorosis continues to be an endemic problem. More and more areas are being discovered regularly that are affected by fluorosis in different parts of the country. It is evident from studies by several researchers worldwide that fluoride in groundwater has been a potential problem to human society. To remediate the groundwater with high fluoride, defluoridation techniques are adopted. But ultimate solution for this fluoride menace remains to be the principal of “Precaution is better than cure”.

REFERENCES

[1] Dhar V, Bhatnagar M. Physiology and toxicity of fluoride. *Indian J Dent Res*. 2009;20(3):350-55.
[2] Fawell J, Bailey K, Chilton J, Dahi E, Fewtrell L, Magara Y. Fluoride in drinking water. London: IWA Publishers; 2006:6-7.
[3] Mandal A, Ray S, Mandal SK, Roy T, Mallik R, Deoghuria D. A Study on Spirometric Evaluation of Lung Volume Restriction in Prediagnosed Cases of Skeletal Fluorosis. *Journal of Evolution of Medical and Dental Sciences*. 2014;3(27):7558-62.
[4] Arlappa N, Atif Qureshi I, Srinivas R. Fluorosis in India: an overview. *Int J Res Dev Health*. 2013;1(2):97-102.
[5] Fluorides and oral health. Geneva: WHO; 1994. 37 pp. Report No: 846.
[6] Muralidharan D, Rangrajan R, Shankar GBK. Vicious cycle of fluoride in semi-arid India – a health concern. *Current Science*. 2011;100(5):638-40.
[7] Sachan S, Singh A, Prakash J, Awasthi G. FLOURIDE: A DOUBLE EDGED SWORD. *World Journal of Pharmaceutical Research*. 2014;3(7):241-54.
[8] Shekar C, Cheluvaiah MB, Namile D. Prevalence of Dental Caries and Dental Fluorosis among 12 and 15 Years Old School Children in Relation to Fluoride Concentration in Drinking Water in an Endemic Fluoride Belt of Andhra Pradesh. *Indian J Public Health*. 2012;56(2):122-28.
[9] Akpata ES. Therapeutic management of dental fluorosis: A critical review of literature. *S J Oral Sci*. 2014;1(1):3-13.
[10] Sherwood IA. Fluorosis varied treatment options. *J Conserv Dent*. 2010;13(1):47-53.
[11] Wikipedia. Skeletal Fluorosis. [Internet] 2014 [cited on 2014 Dec 20] Available from: http://en.wikipedia.org/wiki/Skeletal_fluorosis
[12] Kanthe VN. Water Quality Assessment and Health Survey in Dhundi Village – A Case Study. *International Journal of Research in Advent Technology.* 2014;2(1):38-42.
[13] Piddennavar R, Pushpanjali K. Review on Defluoridation Techniques of Water. The *International Journal of Engineering And Science*. 2013;2(3):86-94.
[14] Iyenger L. Small Community Water Supplies: Technology, People and Partnerships. In: Smet J, van Wijk C (ed). Technologies for fluoride removal. Delft, Netherlands. *IRC*. 2003; 499-514.
[15] Daw RK. Experiences with domestic defluoridation in India. Proceedings of the 30th WEDC *International Conference on People-Centred Approaches to Water and Environmental Sanitation*; 2004 Oct 25-28; Vientiane, Lao PDR; Pp.467–73.
[16] Rajchagool S. The Applied ICOH Defluoridator. In: Dahi E, Bregnhoj H, editors. Proceedings of 1stInternational Workshop on Fluorosis Prevention and Defluoridation of Water. 1995 Oct 18-22; Ngurdoto, Tanzania. New Zealand: *The International Society for Fluoride Research*. 115-17.
[17] Coetzee PP, Coetzee LL, Puka R, Mubenga S. Characterisation of selected South African clays for defluoridation of natural waters. *Water SA*. 2003;29(3):331-38.
[18] Mariappan P, Vasudevan T. Domestic Defluoridation Techniques And Sector Approach For Fluorosis Mitigation. *J Inst Publ Health Eng*. 2002;17-21.
[19] Parlikar AS, Mokashi SS. Defluoridation Of Water by Moringa Oleifera- A Natural Adsorbent. *International Journal of Engineering Science and Innovative Technology.* 2013; 2(5):245-52.
[20] Murugan N, Subramanian E. Studies on defluoridation of water by Tamarind seed, an unconventional biosorbent. *J Water Health*. 2006;4(4):453-61.
[21] Mondal NK, Bhaumik R, Baur T, Das B, Roy P, Datta JK. Studies on Defluoridation of Water by Tea Ash: An Unconventional Biosorbent. *Chem Sci Trans*. 2012;1(2):239-56.
[22] Bhaumik R, Mondal NK, Das b, Roy P, Pal KC, Das C, et al. Eggshell Powder as an Adsorbent for Removal of Fluoride from Aqueous Solution: Equilibrium, Kinetic and Thermodynamic Studies. *E-Journal of Chemistry.* 2012;9(3):1457-80.
[23] Eswar P, Devaraj CG. Water defluoridation: Field studies in India. *Indian Journal of Dental Advancements*. 2011;3(2):526-33.
[24] Dahi E. Contact precipitation for defluoridation of water. Proceedings of 22nd WEDC Conference. 1996 Sept 9-13; NewDelhi, India. 262-65.
[25] Patil SS, Ingole NW. Studies on Defluoridation – A Critical Review. *Journal of Engineering Research and Studies*. 2012;3(1):111-19.
[26] Susheela AK. Epidemiology and Control of Fluorosis in India. *Fluoride*. 1985;18(2):120-21.
[27] Emission Regulations – Part II. New Delhi: Central Pollution Control Board (India). 1998 Feb; Pp. 18.
[28] Susheela AK. FLUOROSIS - Early detection and Management. Importance of practising interventions with focus on consuming safe water and essential nutrients. *Heinz Nutrition Foundation of India In Touch*. 2011;3(3):2-5.
[29] Jecobson P, Dahi E. Bone char based bucket defluoridator in tanzanian households. In: Dahi E, Nielsen JM, editors. Proceedings of the 2nd International Workshop on Fluorosis Prevention and Defluoridation of Water. 1997 Nov 19-25; Nazreth, Ethiopia. New Zealand: The International Society for Fluoride Research. 156-59.
[30] Bravo A, Bregnhoj H, Sakolnakorn JPN, Rattanapibool N. Demand Responsive Fluorosis Prevention in a village in Thailand. In: Dahi E, Rajchagool S, Osiriphan N, editors. Proceedings of the 3rd International Workshop on Fluorosis Prevention and Defluoridation of Water. 2000 Nov 20-24; Chiang Mai, Thialand. 111-19.

[31] Nasakolnakorn JP. Means and Mode of Providing Information to People in their Fluorosis Prevention. In: Dahi E, Rajchagool S, editors. Proceedings of the 4th International Workshop on Fluorosis Prevention and Defluoridation of Water. 2004 Mar 2-6; Colombo, SriLanka. 66-72.
[32] Vaish AK, Vaish P. A Case Study of Fluorosis Mitigation in Dungarpur District, Rajasthan, India. In: Dahi E, Rajchagool S, Osiriphan N, editors. Proceedings of the 3rd International Workshop on Fluorosis Prevention and Defluoridation of Water. 2000 Nov 20-24; Chiang Mai, Thialand. 97-104.
[33] Mythri H, Dinesh, Bennadi D. Current public health perspective of fluorosis mitigation project in Pavagada taluk, Karnataka. *Indian J Occup Environ Med*. 2012;16(3):124-26.
[34] Gautam A, Tripathi RC. Fluoride Testing and Fluorosis Mitigation In Sonebhadra District [Internet]. 2009 [cited on 2014 Dec 12]. Available from: https://ideas.repec.org/p/ess/wpaper/id1853.html
[35] Fluoride Testing and Fluorosis Mitigation nn Nuapada District Orissa: A Small Pilot-Scale Exercise [Internet]. [cited on 2014 Dec 12]. Available from: http://peoplesscienceinstitute.org/PDF's/EQMG/FLUORIDE%20TESTING%20AND%20FLUOROSIS%20MITIGATION%20IN%20NUAPADA.pdf
[36] People's Science Institute, Dehradun. Vasudha Vikas Sansthan (Dhar). Water Aid, India. Report on Fluorosis mitigation program in Dhar District (M.P.) 2011; Pp. 40.
[37] Narayana AS, Khandare AL, Krishnamurthi MVRS. Mitigation of Fluorosis in Nalgonda District Villages. In: Dahi E, Rajchagool S, editors. Proceedings of the 4th International Workshop on Fluorosis Prevention and Defluoridation of Water. 2004 Mar 2-6; Colombo, SriLanka. 98-106.
[38] NEERI, UNICEF. Report on Integrated Fluorosis Mitigation. 2007. Pp. 86.
[39] Department of Drinking Water Supply, Ministry of Rural Development, Government of India. Rajiv Gandhi National Drinking Water Mission, National Rural Drinking Water Programme. 2010. Pp. 46.
[40] Krishnan S, Indu R. Carewater, INREM Foundation. How can we think ahead on Fluorosis Mitigation? [Internet] [Cited on 2014 Dec 22]. Available from: www.inrem.in/fluorosis/pdf/T1p3.pdf

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