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REMOVAL OF FLUORIDE FROM WATER BY USING BIO-ADSORBENTS: A STATE OF ART

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Abstract: - Excess concentration of fluoride creates a problem of health. It affects the human and animals life. World Health Organization (WHO) sets the range of fluoride in ground water is 1 and 1.5 mg/L for India. Fluoride creates a problem of skeletal as well as dental fluorosis. Small amount of fluoride is needed for dental protection. Its concentration less or more than the standard limits creates health problems. Therefore it is necessary to maintain the permissible range of fluoride in drinking water and hence the study of methods available is needed. This revived paper focus over the different adsorbents with various parameters along the feasibility and fluoride removal efficiency.

Keywords: Fluoride, Ground Water, Bio Adsorbent, Adsorption, Removal.

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INTRODUCTION

The excess concentration of fluoride causes the ill effect on the health. Fluoride is responsible for dental caries and at the same time high concentration dose is for skeletal fluorosis and hence the excess fluoride in drinking water is a globally accepted problem. Required dose of fluoride is beneficial for the growth of bones and calcification of dental enamel when provides within the range. After the study of several existing methods the precipitation and adsorption method of defluoridation are mostly preferred. The most commonly adopted method in India is a Nalgonda technique of community defluoridation, which is based on precipitation process. [1]. The existing traditional methods like chemical precipitation, ion exchange, membrane separation and electro deposition have been used for the removal process of fluoride [2].The method of adsorption is used worldwide because of its cost effectiveness and good removal efficiency for the removal of different ions from water. Country to country fluoride content varies which is depends on geography and the age of people involved [3].

2. WORLDWIDE SCENARIO

According to WHO, the tolerance limit of fluoride in drinking water is 1.5 mg/L [4]. In global situations Indian, Chinese and North African peoples affected from the fluoride poisoning. Worldwide 200 million peoples from 25 nations are facing the problem of excess fluoride in drinking water [5].

The countries Argentina, U.S.A., Morocco, Algeria, Libya, Egypt, Jordan, Turkey, Iran, Iraq, Kenya, Tanzania, S. Africa, China, Australia, New Zealand, Japan, Thailand, Canada, Saudi Arabia, Persian Gulf, Sri Lanka, Syria, India, etc. faced the problem of endemic fluorosis [6].

3. HEALTH EFFECT

Daily excess dose of fluoride creates a several fluorosis, It spreads physiological disorder properties also. Low concentration stabilizes the dental fluorosis while in excess concentration of fluoride stabilizes skeletal fluorosis. For the precaution and protection of dental caries, small amount of fluoride ion is always essential. The first sign of fluoride toxicity is dental fluorosis [7]. The researchers Fewtrell et al. have estimated that high fluoride concentrations in drinking water have caused about 47 million of dental fluorosis cases and 20 million skeletal fluorosis cases in 17 countries [8].

4. OBJECTIVES OF REVIEW

The present review studies the objectives towards the feasibility of adsorption techniques with efficiency of removal of fluoride ions by using available various low cost efficient bio adsorbents used in the process of effective removal of excess fluoride concentration from ground water.

5. REGULATION OF FLUORIDE

The main objective for setting regulation of fluoride is to reduce the level of fluoride up to the permissible limits as possible taking into consideration occurrence, human exposure, toxicology and cost of technology. Based on above considerations, different authorities have suggested permissible level of fluoride in drinking water table-1 and State wise average levels of fluoride given by UNICEF in table-2.

6. FLUOROSIS FACTORS

i. The heavy rate of fluorosis is depends on heavy injected dose quantity of fluoride.

ii. In many regions for the purpose of drinking, cooking and bathing high range fluoride ground water sources used which causes fluorosis.

iii. The contribution of additional fluoride by the consumption of certain locally available foods such as vegetables ,fish, meat, chicken, eggs, rice, tea, milk etc.

7. TREATMENT TECHNOLOGIES

Different methods of treatment in laboratory and field conditions have been adopted to remove and regulate the level of fluoride in drinking water below the maximum contamination level. Many methods have been used for the removal of excess concentration of fluoride from water such as Adsorption, ion exchange, Precipitation, Donnan dialysis, electro dialysis, reverse osmosis, nano filtration and ultra filtration.

8. BIO-ADSORPTION

A.V.Jamode, et.al. (2004) checked the feasibility of low cost bio leaf adsorbents to minimize the excess concentration of fluoride ions. The trees leafs of neem (Azadirachta indica), pipal (Ficus religiosa) and khair (Acacia catechu willd) were used for the adsorption study. Researchers were concentrated over the higher 15 mg/L dose. During the study it was found that the fluoride concentration decreases gradually to 0 mg/L for the temperature of 29 ± 0.5°C, time 180 minutes with a dose of 10g/L. It follows Langmuir isotherm [9].

Sunil Kumar et.al. (2008) investigated the efficiency of thermally activated neem (Azadirachta indica) leaves carbon (ANC) and thermally activated kikar (Acacia arabica) leaves carbon (AKC) for the removal of excess quantity of fluoride from synthetic solution. The adsorbents were prepared for the batch adsorption studies. The batch process studies pH, adsorbent dose, contact time was optimized on synthetic sample of 5 ppm of fluoride. The optimum pH was found 6 for both adsorbents for the optimum dose of 0.5g/100 ml for ANC (activated neem leaves carbon) and 0.7g/100 ml for AKC (activated kikar leaves carbon).The optimum time was found to be one hr. for both the adsorbent. It was also found that adsorbent size of 0.3 mm was more efficient than the 1.0 mm size. The adsorption followed Freundlich isotherm [10].

D.Mangrulkar, et.al. (2011) studied and checked the efficiency of Seed Coat of Tur (SCOT) in batch process for fluoride removal from aqueous solution. The maximum fluoride removal was obtained at pH 8.0. The adsorption capacity of SCOT was found 4.36 mg/g. Langmuir model was best fitted [11].

Bhagyashree M Mamilwar, et.al. (2012) evaluated the efficiency of babool bark as an adsorbent for the removal of fluoride from water. The experiments were carried out in batch process in laboratory. Researchers used Freundlich and Langmuir isotherms to understand the adsorption mechanism. For the initial concentration 5 ppm the optimum dose of bark of babool was found 5g/L. Maximum efficiency of removal of fluoride was found in the range of pH 6-8 for the time of contact 8 hrs. Equilibrium data fits better to Langmuir isotherm [12].

Patil Satish, et.al. (2012) studied different bio adsorbents were tested in batch process to investigate the efficiency of Mangrove plant leaf powder (MPLP), Almond tree bark powder (ATBP), Pineapple peel powder (PPP), Chiku leaf powder (CLP), Toor plant leaf powder (TPLP) and Coconut coir pith (CCP).Each adsorbent were tested to observed the effect of pH, contact time, adsorbent dose and initial metal ion concentration to remove fluoride ions using batch studies. The result were found that the optimum contact time of 60 min. for the initial concentration 5ppm with a dose of 10 g/L and the high fluoride concentration was observed at pH 2 [13].

S. A. Valencia-Leal, et.al. (2012) investigated the bio adsorbent for the removal of fluoride from synthetic solution. The adsorption method was used as a medium of low cost adsorbent, Guava Seeds (Psidium Guajava). The study observed the maximum efficiency of adsorbent for the pH 5.0 to 8.0. The Langmuir and Freundlich isotherm were used [14].

R. Merugu, et.al. (2013) studied the fungal bio sorbent prepared from Aspergillus nidulans was used for removal of fluoride from water. The experiments proved that the calcium and alkali

treated biomass was effective in the process of removal of fluoride. The study were carried out in batch process and found that the defluoridation was dependent on the initial pH and decreased with increasing pH. The maximum removal capacity was found to be 29 % at pH 4.0 while it was 14% at pH 8.0. The researchers reported that the chloride and sulphate did not affect fluoride removal [15].

M. Mehdi Mehrabani Ardekani, et.al. (2013) studied the comparison of Bagas, Modified Bagas and Chitosans efficiency for the removal of excess concentration of fluoride by adsorption method. The comparised results found that the dose of adsorbent 2g/l with a pH value 7 for a contact time of 60 minutes for the adsorbents Bagas, Modified Bagas and Chitosans. The comparison also shows the adsorbents Bagas and Chitozan did not have a good capability for the removal of fluoride. Modified bagas showed a good efficiency more than of 90%. For a optimum dose of 2 g/L with contact time 60 minutes at pH 7 In adsorption Langmuir and Freundlich models were used [16].

D. Chaitanya Devanand, et.al. (2014) investigated that the bio adsorbent for defluoridation is more beneficial than conventional adsorbents such as alumina, activated carbon etc., both in terms of quality and quantity. In researcher□s experimental studies, they have used dry biomass of Spirulina platensis as a bio-adsorbent to defluoridate water samples. Based on the studies pH, adsorbent dosage, initial fluoride concentration and contact time, they have found that in lab scale, at pH 5 and adsorbent dosage of 1.0g/100ml and at the fluoride concentration of 20 mg/l, maximum adsorption (97.10%) takes place. Langmuir isothermal model suits well for the adsorption of fluoride from water using Spirulina as bio adsorbent [17].

Aash Mohammad, et.al. (2014) The work was carried out for the design and develops a novel, cost effective strategy for fluoride removal from industrial waste water. The experiments were carried out in laboratory to investigate the feasibility adsorbents, banana peel, groundnut shell and sweet lemon peel for industrial waste water defluoridation at neutral pH range. The used adsorbents were compared with commercially available adsorbents. This study shows better high removal efficiency at higher concentration (20 mg/l) of fluoride in industrial waste water. The banana peel, groundnut shell and sweet lemon peel removed 94.34, 89.9 and 59.59 % [18].

(Table: 1)

Fluoride Levels in Indian States mg/L		Fluoride Levels in Indian	
Andhra	0.4 - 29.0	Kerala	0.2 - 5.40
Assam	1.6 - 23.4	Madhya	1.5 - 4.20

Bihar	0.2 - 8.32	Maharashtra	0.11 - 10.00
J & K	0.5 -4.21	Orissa	0.6 - 9.2
Delhi	0.2 - 32.0	Punjab	0.4 - 42.0
Gujarat	1.5 - 18.0	Rajasthan	0.10 - 10.0
Haryana	0.2 -48.32	Tamil Nadu	0.1 - 7.0
Jharkhand	0.5- 14.32	Uttar Pradesh	0.2 - 25.0
Karnataka	0.2 - 7.79	West Bengal	1.1-14.47

(Table: 2)

SN	Authority	Per. Limit, mg/L
1.	WHO (In Indian context)	1.50
	WHO (International Std.)	0.50
2.	BIS (IS-10500)	1.0-1.5
3.	ICMR	1.0-2.0
4.	CPHEEO	1.0-1.5
5.	US Public Health	0.7-1.2

9. CONCLUSION

I. The doses of adsorbents at different pH affect the efficiency of removal of fluoride.

II. The temperature variation, time of contact affects the % removal of fluoride.

III. The presence of different co-existing ions in a water sample affects the % removal of fluoride.

IV. In some cases the percent removal of Fluoride increases with the increase in adsorbent dose up to a certain limit and then remains almost constant.

V. The study indicates the ability of bio-adsorption in economic way.

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