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Research Article

A COMPARATIVE STUDY OF DE-FLUORIDATION OF GROUNDWATER WITH *MORINGA OLEIFERA* BIO-ADSORBENT AND ACTIVATED CHARCOAL ADSORBENT

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Key words: Fluoride removal, *Moringa oleifera*, Activated charcoal, Bio-adsorbent, Water quality.

ABSTRACT

Fluorides are the most important pollutants present in the effluents from various industrial and groundwater sources. These are very poisonous to living beings and have a dangerous effect on their health. Fluoride in drinking water within permissible limits of 0.5-1.0 mg/L is useful for the production and of maintenance healthy, teeth and bones as extreme intake of fluoride causes dental and skeletal fluorosis. Thus the removal of fluoride using adsorbents is a main step towards the protection of environment. Adsorption is the mainly effective and widely used method and is suitable for the removal of fluoride. This paper presents the results of investigations carried out for removal of fluoride from water by using low cost adsorbents *Moringa oleifera (*MO) seed and Activated Charcoal. The highest removal of fluoride is significantly done by activated charcoal (81.17%) as compare to *Moringa oleifera* (69.82%).

INTRODUCTION

Ground water is the significant source of drinking, industrial & agricultural purpose. It is an important and incorporated branch of hydrological cycle. Groundwater availability depends upon the precipitation and percolation of rain water through soil. Increase demand of groundwater for agricultural and industrial use may lead the sharp decline in ground water level and change in the natural geochemistry of groundwater. Natural contamination such as fluoride, arsenic, nitrate salts continuously increasing in groundwater in level which make unfit for drinking reason even pose a danger to health (PHED, 2004).

Fluoride is thirteenth most abundant element in earth and is available as fluoride ion in earth crust in diversity of compounds such as sodium fluoride, fluorspar, sodium fluorosilicate etc. It is most electronegative of all elements (Buddharatna, *et al*., 2014). Within limits, fluoride is essential for humans. It prevents infants from dental caries. Fluoride is a generally occurring element in minerals, geochemical deposits and usual water system and enters food chains through either potable water or eating plants or cereal (Ravikumar, *et al*., 2015). The groundwater containing high levels of fluoride is used for drinking purpose this usage of fluoride contaminated water over a duration of time causes health problem such as fluorosis i.e., deformation of dental, skeletal, non skeletal and also hazardous effects (Rao, *et al*., 2009). The removal of fluoride from water is single of the most significant issues due to its ill effects on human being health and environment. According to world health organization the maximum permissible limit of fluoride concentration in drinking water is 1.5 mg/L (Mondal, *et al*., 2012; Malakootian, *et al*., 2011). This study is an attempt to remove the fluoride from water by using low cost adsorbents.

MATERIALS AND METHODS

Water sampling

The total thirty samples are collected from hand-pump, wells and tube-wells sine dissimilar villages of Jaipur district during summer, winter and rainy of year 2016-2017. Previous to sampling, the water is

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left to run from the source for few minutes. Then in the laboratory conditions, water sampling was done from each selected place.

Materials

In this study an attempt has been made to advise certain low-cost materials as impressive adsorbents of fluoride. Naturally occurring and abundantly available materials like *Moringa oleifera* seed and Activated Charcoal be used as adsorbents.

Preparation of MO Seed Powder

The dry drumstick (*Moringa oleifera*) ponds are collected from local tree. Pod shells are removed manually, and kernels be grounded in a domestic blender. 40 gm of MO powder sample was added to 400 ml of 1N HNO_3 for acid treatment and 0.5N NaOH for alkali treatment. The mixture was boiled for about 20 minutes. Washing of the powder sample was carried out by using distilled water until maximum colour was removed and clear water was obtained. Finally, it was dried again in an oven at 50°C for 6 hrs. (Fig. 1).

Analysis of Fluoride Concentration of Groundwater

The study for presence of fluoride in groundwater samples is carried out as per APHA standard methods. Fluoride concentration be determined with SPANDS method spectrometric ally by use zrconyl-SPADNS (sodium 2-(parasulphophenylazo)-1, 8-dihydroxy-3, 6-naphthalene-disulphonate) reagents.

RESULTS AND DISCUSSION

(Tang, *et al*., 2009; Emmanuel, *et al*., 2008; Sun, *et al*., 2011; Kamble, *et al*., 2007; Kumar, *et al*., 2011; Tembhurkar, *et al*., 2006; Maliyekkal, *et al*., 2006) have worked with many adsorbent materials and tested for fluoride removal consists activated alumina, activated charcoal, zeolite, biosorbent and nanosorbents. Activated charcoal is considered as universal adsorbent because of its application and viability. Activated charcoal is also effective adsorbent used for fluoride removal from water, but it has limited regeneration capacity and slow rate of adsorption.

The conventional technique of fluoride removal includes- reverse osmosis, ion-exchange and adsorption. The reverse osmosis, ion-exchange is comparatively exclusive. Then, still adsorption is the workable method used for the removal of fluoride. Defluoridation of drinking waters is generally able by either precipitation or by adsorption process. Single of the well-known methods called Nalgonda technique was developed by National Environmental Engineering Research Institute; Nagpur, India (Bulsu and Nawlakhe, 1988) is precipitation processes employing alum followed by sedimentation and filtration. Difficulty of this method is that treated water has high residual aluminium concentration (2-7 mg/L) then the WHO standard of 0.2 mg/L (Tomar and Kumar, 2013). Alum coagulant can be use to

Fig. 1 Preparation of MO seed powder.

remove fluoride selectively from aqueous solutions. Still at 60-70% removal, the left over fluorides were within the permissible limit for drinking water (Subhashini, *et al*., 2012). Aluminum in drinking water poses possible risks to humans. Aluminium is strongly neurotoxic and possibly involved in the development of Alzheimer's disease (Rajendran, *et al*., 2013). Currently, adsorption method is more effect or attractive method for removal of fluoride from water. The higher value of fluoride in Summer Season period may be due to the evaporation, lowering of water table and geological rock system (Das and Talukdar, 2003).

Owing to rich biodiversity of India, a big number of plant spices are available for treatment of different toxicities and musculoskeletal disorders. Research information indicates that herbal and low-cost plant products may be used for mitigation of fluoride toxicity (Stanley, *et al*., 2000). The purpose of the current study is to investigate the efficiency of naturally occurring and low-cost materials like Activated charcoal and *Moringa oleifera* seed for removal of fluorides from water.

The experiments were performed at different material (Drumstick seed and activated charcoal), adsorbent dosage (1 g), for removing fluoride from groundwater. The present study provides the comparison of fluoride removal efficiency of adsorbent such as *Moringa oleifera*, Activated Charcoal. The seasonal fluoride concentration is shown in Table 1 and (Fig. 2). The adsorption removal percentage (%) of fluoride in a ground water using drumstick (*Moringa oleifera*) seed powder and activated charcoal be calculate by use the following formula:

Table 1. Fluoride concentration at various stations with summer, winter and rainy seasons are summarised.

S. No	Initial seasonal fluoride concentration mg/L			Final fluoride concentration (Dosage of MO) mg/L			Final fluoride concentration (Dosage of AC) mg/L		
	Summer season	Winter season	Rainy season	Summer season	Winter season	Rainy season	Summer season	Winter season	Rainy season
1	1.471	1.027	1.289	0.785	0.272	0.480	0.299	0.201	0.332
2	1.451	1.119	1.384	0.775	0.369	0.546	0.322	0.175	0.299
3	1.528	1.106	1.371	0.880	0.356	0.513	0.223	0.191	0.314
4	1.574	1.027	1.289	0.896	0.267	0.485	0.243	0.214	0.322
5	1.358	1.081	1.273	0.451	0.341	0.459	0.268	0.216	0.378
6	1.461	1.029	1.374	0.752	0.367	0.503	0.250	0.183	0.355
7	1.507	1.106	1.368	0.844	0.359	0.472	0.157	0.188	0.396
8	1.507	1.137	1.397	0.850	0.385	0.616	0.150	0.160	0.124
9	1.510	1.160	1.420	0.857	0.415	0.626	0.139	0.119	0.319
10	1.422	1.070	0.999	0.493	0.326	0.418	0.481	0.229	0.327
11	1.417	1.145	1.204	0.475	0.398	0.487	0.250	0.129	0.378
12	1.394	1.153	1.194	0.469	0.403	0.475	0.260	0.116	0.409
13	1.679	1.078	1.343	0.909	0.058	0.441	0.513	0.198	0.283
14	1.625	1.178	1.446	0.904	0.141	0.498	0.505	0.129	0.368
15	1.566	1.083	1.350	0.883	0.349	0.454	0.236	0.173	0.188
16	1.926	1.160	1.682	1.035	0.344	0.731	0.133	0.102	0.213
17	1.759	1.158	1.677	0.965	0.331	0.724	0.462	0.092	0.195
18	1.682	1.171	1.438	0.937	0.382	0.629	0.446	0.112	0.188
19	1.646	0.983	1.255	0.755	0.433	0.449	0.247	0.305	0.378
20	1.733	1.104	1.628	0.957	0.469	0.788	0.451	0.344	0.291
21	1.785	1.104	1.636	0.991	0.451	0.793	0.493	0.331	0.275
22	1.481	1.276	1.420	0.806	0.482	0.593	0.257	0.383	0.340
23	1.708	1.474	1.679	0.929	0.634	0.898	0.415	0.550	0.169
24	1.736	1.582	1.700	0.963	0.731	0.916	0.472	0.376	0.195
25	1.692	1.268	1.263	0.932	0.398	0.459	0.238	0.239	0.381
26	1.625	1.243	1.261	0.901	0.356	0.444	0.121	0.286	0.396
27	1.666	1.261	1.512	0.773	0.444	0.616	0.191	0.396	0.273
28	1.422	0.999	1.207	0.485	0.400	0.639	0.396	0.347	0.576
29	1.546	1.263	1.366	0.891	0.467	0.480	0.119	0.388	0.337
30	1.451	1.086	1.243	0.778	0.359	0.433	0.175	0.283	0.368
Average	1.577	1.154	1.388	0.810	0.382	0.568	0.297	0.238	0.3122

$$Percentage(\%)\,Removal = (C_1 - C_2)/C_1 \times 100$$

Where C_1 is the concentration of fluoride in mg/L before treatment with *Moringa oleifera* and activated charcoal, C_2 is the concentration of fluoride in mg/L after treatment with *Moringa oleifera* (MO) and activated charcoal (AC). The results of the 30 samples for removing fluoride from groundwater by *Moringa oleifera* seed powder and activated charcoal are given in Table 2 and (Fig. 3).

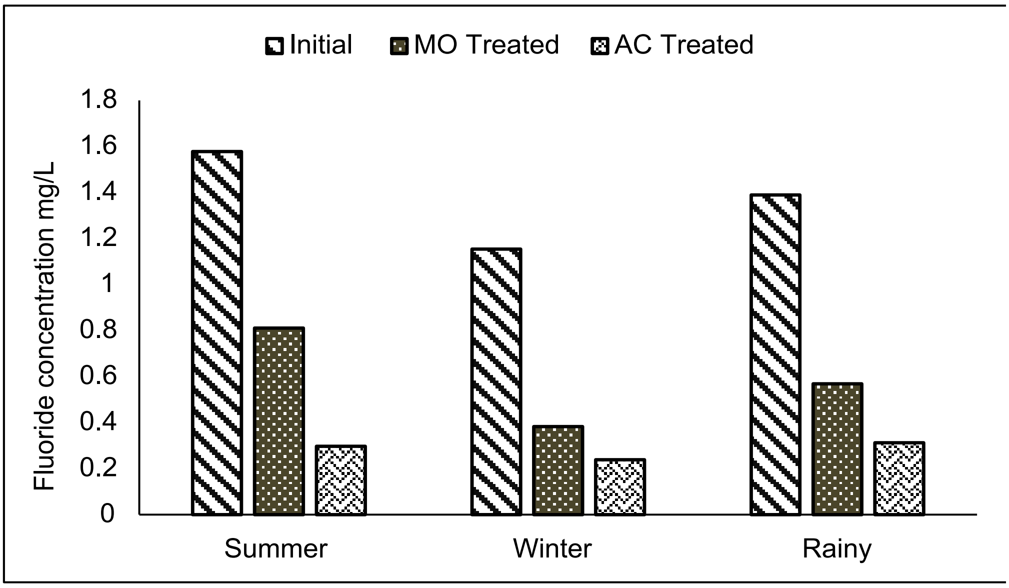

Fig. 2 Fluoride concentration in summer, winter and rainy.

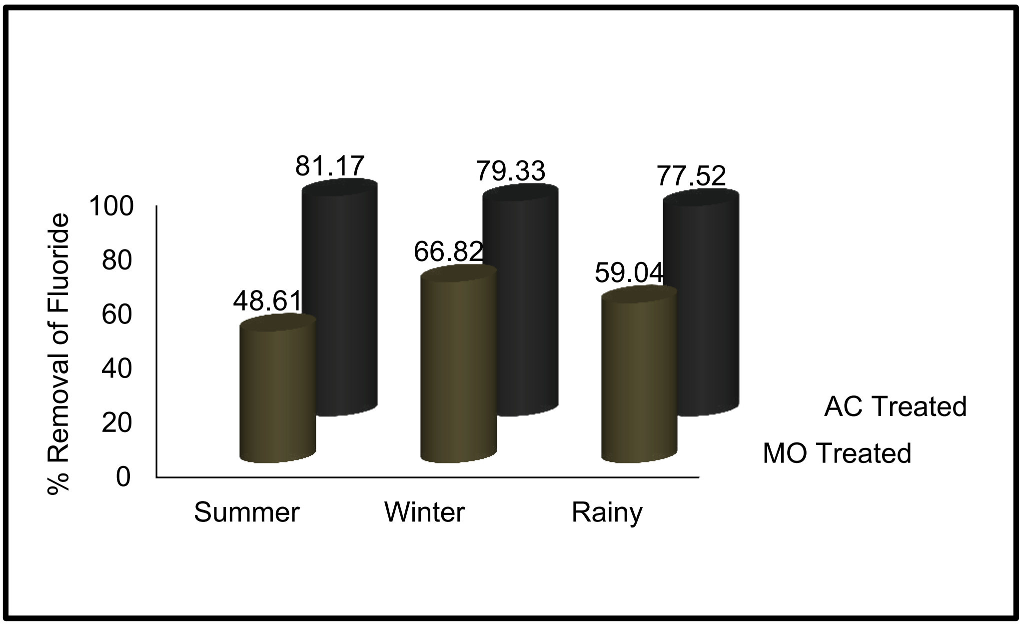

Fig. 3 Percentage removal of fluoride by MO and AC.

Table 2. The percentage removal of fluoride from groundwater using *Moringa oleifera* seed powder and activated charcoal.

Seasons	Initial fluoride average value	Final MO average value	Final AC average value	Percentage Removal of MO and AC	
				MO%	AC%
Summer	1.5776	0.8107	0.2970	48.61	81.17
Winter	1.1543	0.3829	0.2385	66.82	79.33
Rainy	1.3889	0.5688	0.3122	59.04	77.52

CONCLUSION

Drinking water is an essential basic need. Hence populace should consume protected water containing fluoride within the prescribe limits. If not, they will be affected by dental and skeletal fluorosis. Based on the results of this study, it can be concluded that the low-cost adsorbents are effective in removal of fluoride from water. Activated charcoal gives the maximum removal of 81.17% of fluoride from water. Drumstick gives the removal of 69.82% of fluoride from water. So that, activated charcoal can effectively remove fluoride as compare to *Moringa oleifera* seed powder. The current study can find use in the development of sustainable, low-cost, eco-friendly and household water treatment system for removal of fluoride most suitable for rural populace of developing country.

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