Defluoridation Of Water Using Pipal Leaf (Ficus Religiosa) As Adsorbant

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Abstract- *Fluoride is an essential element in drinking water. At small doses it is good for the dental cares and health but higher doses of fluoride will causes problems like dental and skeletal fluorosis. By using natural adsorbants fluoride can be removed effectively. This study aims to find the defluoridation capacity of Ficus Religiosa (pipal) leaf in water. Effect of some major parameters like pH, contact time, adsorbant dosage and initial adsorbate concentration on defluoridation was investigated.*

Keywords- Defluoridation, Natural adsorbants, Ficus Religiosa, pH, Contact time, Adsorbant dosage, Initial adsorbate concentration

I. INTRODUCTION

Now a days there are scarcity for the availability of fresh and pure water for drinking purposes. This is due to the generation of large amount of wastewater produced from industrial, agricultural and domestic activities. These wastewater containing many toxic pollutants which will affect the freshwater sources.

Fluoride is “more toxic than lead and less toxic than arsenic” and is an accumulative toxin. Fluoride has dual significance; if its content is less then it may result in problems like dental caries. World Health Organisation (WHO) recommends it in the range of 0.1– 0.5 ppm. [3]

Defluoridation of drinking water is the only feasible option to root out the problem of excessive fluoride in from water, where alternate source is not available. There are many methods exist to remove fluoride from contaminated water i.e. adsorption, Ion exchange, electrodialysis, coagulation/ precipitation, Donnan dialysis, reverse osmosis, nanofiltration and ultrafiltration have been investigated [17]. Adsorption is the viable method for the removal of fluoride. Plant materials are reported to accumulate fluoride and hence application as defluoridating agents has been suggested.[15]

II. METHODOLOGY

A. Materials

The adsorbent which is used is pipal leaf for the removal of fluoride from the water. The natural adsorbent is collected from the pipal tree.

B. Adsorbent preparation

Fresh leaves chosen based on their crude fibre content and tress were obtained from pipal (Ficus religiosa) trees. The fresh leaves were sun-dried for 3–4 days, put in a cotton jute bag and crushed manually. This process can save the energy expended in hot air oven drying and mechanical crushing. The powder was sieved to get various particle sizes. Leaf powder biomass was further digested by chemical methods.

C. Preparation of stock solution

Fluoride stock solution was prepared by dissolving 221 mg anhydrous sodium fluoride in 1000 ml distilled water in volumetric flask. Fluoride standard solution was prepared by diluting 100ml stock solution to 1000 ml distilled water in volumetric flask. This 1 ml solution has 0.1 mg of fluoride.

D. Alkali treatment

Leaf biomass powder sample (40 gm) and 400 ml 0.5 N NaOH were taken in 1000-ml conical flask. Then mixture was gently heated on burner for 20 min after boiling started. Using distilled water, the treated biomass was washed which continued until maximum colour was removed and clear water obtained.

E. Preparation of reagent

Zirconyl – SPADNS reagent is used for the analysis of fluoride.

a) SPADNS solution: Dissolve 958 mg SPADN (sodium 2-1,8-dihydroxy-3,6-naphthalene disulfate) in distilled water and dilute to 500 ml.
b) Zincronyl – acid reagent: dissolve 133mg zincronyl chloride octahydrate in about 25ml distilled water. Add 350 ml conc. Hcl and dilute to 500 ml with distilled water.

c) Acid Zincronyl – SPADNS reagent: Mix equal volum of SPADNS and zincronyl – acid reagent.

III. RESULTS AND DISCUSSIONS

Adsorption studies were performed by batch technique to obtain the rate and equilibrium data. Experiments were carried out by shaking 10 g/l of adsorbent dose with 100 ml of aqueous solution containing known concentration of fluoride ions and by agitating the samples at a speed of 200 strokes/min. Samples containing fluoride ions were maintained at a desired pH by adding 0.5 N HNO3. All the experiments were conducted at room temperature (27 ± 0.5°C).

Fig.1 Alkali treated leaf powder

A. Effect of initial adsorbate concentration

For a strictly adsorptive reaction, in the optimized period of contact, the rate varies directly with the concentration of adsorbate. The capacity of the adsorbent materials gets exhausted sharply with increase in initial fluoride ion concentration. The adsorption capacity of treated biosorbents was systematically studied by varying the initial concentration of fluoride ions between 2 and 10 mg/l.

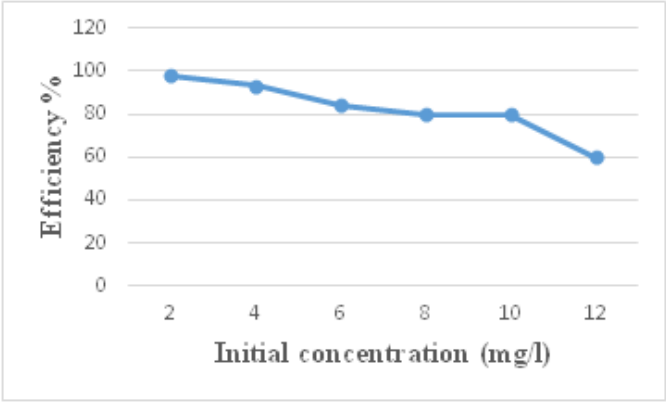

Fig.2 Effect of initial concentration on removal of fluoride ion

The percent removal of fluoride ion is a function of initial concentration at different initial pH values. Treated biosorbents may be seen fairly active in reducing fluoride ions from 100 to 60 % when the initial concentration of fluoride ion concentration was increased from 2 to 12 mg/l with a constant sorbent dose of 10 g/l at pH of 2.

B. Effect of contact time

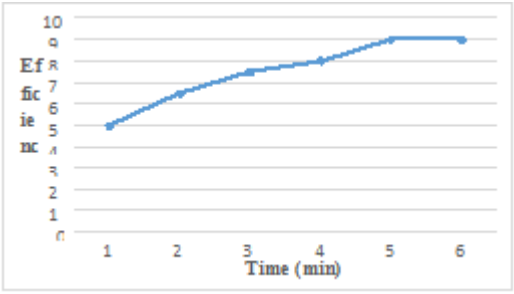

Fig. 3 Effect of contact time on the removal of fluoride ion

It is found that the removal of fluoride ions increases with increase in contact time to some extent. Further increase in contact time does not increase the uptake due to deposition of fluoride ions on the available adsorption sites on adsorbent material. Preliminary investigations on the uptake of fluoride ions on the adsorbent material at their optimum pH values indicate that the processes are quite rapid. Typically, 80% of the adsorption occurs within the first hour of the contact for fluoride ions with an initial concentration and adsorbent dose of 10 mg/l for treated biosorbents. This initial rapid adsorption subsequently gives way to a very slow approach to equilibrium and saturation is reached in 1.5 to 3 h. For further optimization of other parameters, this contact time was considered as the equilibrium time.

C. Effect of pH

It is observed that decrease in the extent of removal of fluoride ions with increase in the pH of the solution. Hence

further studies were conducted within these pH values. In the case of treated biosorbents, the percentage of adsorption increased almost linearly between 2.0 and 8.0, attaining a maximum removal at pH 2.0 in 60 min of contact time.

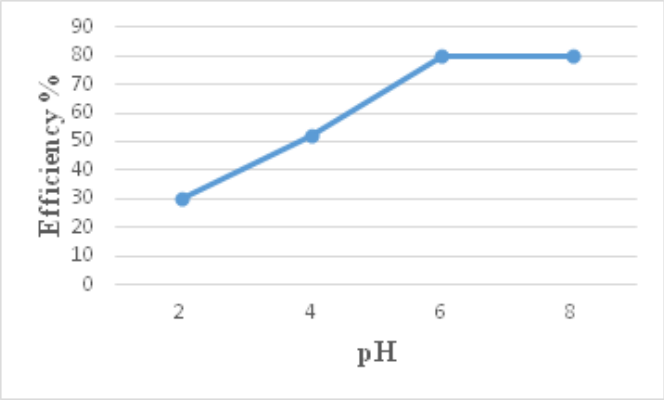

Fig. 4 Effect of pH on the removal of fluoride ion.

D. Effect of adsorbent dosage

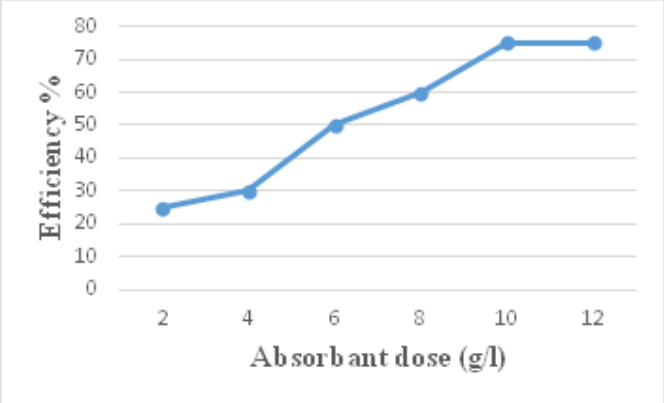

Fig. 5 Effect of adsorbent dose on the removal of fluoride ion

It is observed that the removal of fluoride ions increases with an increase in the amount of adsorbent. For all these runs, initial fluoride ion concentration was fixed at 10 mg/l. The amount of adsorbent dose was varied between 2 and 12 g/l in aqueous solution at their optimal pH values.

IV. CONCLUSIONS

The pipal leaf powder is found to be an efficient adsorbent for the defluoridation of drinking water sources. The biosorbent was successful in removal of fluoride ions from aqueous solution of 10mg/l fluoride concentration with about 90% efficiency.

Treated bio adsorbents were observed to be efficient for the uptake of fluoride ions between 2.0 and 8.0 pH. Fluoride removal for a given bio adsorbent size increased with time attaining equilibrium within 1h. The percentage of fluoride removal was found to be a function of time at a given initial solute concentration. It increased with time, and higher initial solute concentration decreased with time. Treated biosorbents can be disposed off safely by burning after use. Treated biosorbents are locally available and hence involve no expenditure on transportation and have a very low cost for pre-treatment. There is no need to regenerate the exhausted treated biosorbents as they are available abundantly, easily, cheaply and locally.

From the above discussions the following conclusions are made:

i. The optimum pH for the removal of fluoride by the investigated adsorbents is 6.
ii. The optimum adsorbent dose for the investigated adsorbent is 10 g/l for the removal of fluoride from water.
iii. The optimum contact time for the removal of fluoride from water was observed at 50 minutes.

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