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Comparitive Study on Deflouridation of Water using LECA Balls and Natural Bioabsorbents

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***Abstract*:- Environmental contamination due to various chemicals and its subsequent harmful health effects in obvious forms in all living creatures including human and animal merits serious attention worldwide. Fluoride is an essential micro element for human health.**

Defluoridation refers to method of water treatment that reduces the concentration of fluoride in the water. This technique is used for the removal of excess fluoride from the aqueous solution using tamarind fruit cover and LECA balls.

Fluoride is often described as a 'double-edged sword' as inadequate ingestion is associated with dental caries, where as excessive intake leads to dental, skeletal and soft tissue fluorosis-which has no cure. Considering the fact that fluorosis is an irreversible condition and has no cure, prevention is the only solution for this menace. Providing water, with optimal fluoride concentration is the only way by which the generation yet to be born can be totally protected against the disease. Defluoridation was the conventional and widely tested method for supplying safe water to the fluorosis affected communities. Various techniques and materials were tried throughout the world for defluoridation of water.

Keywords; Deflouridation Of Water, LECA Balls, Tamrind Gel Cover, Removal Efficiency, Wieght of bioabsorbents

INTRODUCTION

One of the major environmental problems around the world is the fluoride related health hazards. More than 25 nations of the world including India suffer from the contamination of luoride in drinking water. Orissa is one of the states where 10 out of the 30 districts is suffering from fluoride contamination. Depending on the concentration and consumption of its total amount, fluoride ions in water have beneficial as well as detrimental effects . Human health is adversely affected due to the presence of fluoride in excess amount . Above a certain limit, fluoride affects every living organism viz. plants, animals, humans. Fluorine is also an essential element for animals and humans. For humans, however, the essentiality has not been demonstrated unequivocally, and no data indicating the minimum nutritional requirement are available. The benefits of low fluoride dosing and the risk of high fluoride dosing have been studied.

are affected by fluoride contamination in water. This involves about 9000 villages affecting 30 million people.

It must be noted that the problem of excess fluoride in drinking water is of recent origin in most parts. Digging up of shallow aquifers for irrigation has resulted in declining levels of ground water. As a result, deeper aquifers are used, and the water in these aquifers contains a higher level of fluoride.

- To compare the fluoride removal efficiency of different materials on water
- To study the effect of pH of different materials on fluoride removal of water
- To identify drawbacks in various deflouridation techniques

METHODOLOGY SAMPLE PREPARATION

Collection of samples from different locations of Aluva,Edapally,Palluruthy.Due to the absence of fluoride in water sample ,stock solutions are prepared for experiments.One litre of fluoride stock solution (1000 mg/L) was prepared, by dissolving 2.21 grams of NaF in deionised water and filling up to mark for one litre. Subsequently the stock solution was diluted with deionised water to get other subsequent concentrations as when required.

EXPERIMENT

Lightweight expanded clay aggregate takes the form of small balls or pellets. These are formed from special "plastic" clay that is fired in a rotary kiln. During the kilning processes, gases created released by the heat warm and expand, inflating the balls and forming a honeycomb structure.Light expanded clay aggregate is strong, durable.LECA can be used in heavy soils to prevent compaction and enhance aeration.When mixed with soil LECA helps enhance drainage. However, they also absorb and retain water, meaning that they can help ensure healthy plant growth during dry periods of the year. These clay balls also retain heat very well, which makes them an excellent option for insulating plant roots during cooler periods of the year.excellent capillary properties.low salt content.no breakdown or decay.

Surface modification of LECA balls were done.Initial modification by nitric acid and final by aluminium chloride

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Roughly powder the LECA balls as required. Weigh 10g of LECA powder.Prepare 100ml 0.01M nitric acid solution. Mix LECA powder with the nitric acid solution thoroughly.Keep the solution in the oven at 105°C for 48 hours.

After 48 hours, take the sample from oven and filter it 1mm (Pore Size) filter paper. Then was the content with distilled water roughly for 8 times (With 50ml of distilled water each time). Keep the final content again in oven at 105°C for another 48 hours.

Pre-treatment of tamarind gel cover is carried out. Tamarind fruit cover was washed with distilled water. And dried in an oven at 100°C for half an hour. The dried fruit cover was powdered. Experiments were carried out using magnetic stirrer. The effect of some major parameters like contact time, and particle size of adsorbents are calculated. pH of solutions also determined.

PROCEDURE

Fluoride standards in the range of 0 to 1.4 mg F−/L were prepared by diluting appropriate quantities of standard fluoride solution to 50mL. 10 mL of the reagent S were added to each of the standards and mixed well. The standard which has 0 mg F−/L was taken as the reference solution and the spectrophotometer was set to zero absorbance. The absorbance readings of other standards were taken with respect to the reference solution and were used to construct the calibration curve.

A slightly modified version of the above mentioned procedure was used to measure fluoride concentrations greater than 1.4 mg/L. Through this method we can find fluoride concentration up to 5 mg/L in water. Fluoride standards in the range of 0 to 5 mg F−/ L were prepared by diluting appropriate quantities of standard fluoride solution to 50 mL. 5 mL of each of these standards were pipetted out in separate beakers and 5 mL of the reagent S were added to each of these beakers and the volume was made up to 30 mL using deionised water in each beaker. A solution prepared by adding 5 mL of reagent S to 25 mL of deionised water was used as the reference solution. The absorbance readings of other standards were taken with respect to the reference solution and were used to construct the calibration curve.

RESULTSAND DISCUSSIONS

The experiment provides the comparison of fluoride removal efficiency of tamarind cover and LECA balls from a solution contaminated with 10 mg/l fluoride under variable experimental conditions such as contact time, pH and weight of adsorbent. From the calibration curves fluoride of different water samples are obtained.

EFFECT OF CONTACT TIME ON FLOURIDE REMOVAL EFFICIENCY

The effect of agitation time was found to be increasing up to a certain period of time. Studies on effect of contact time on the fluoride removal efficiency was carried by varying it from 30 minutes to 120 minutes with initial fluoride concentration of 10 mg/L. Table 4.1 and 4.2 shows that the flouride removal efficiency of flouride at different time periods. Figure 4.1 and 4.2 are graphs plotted with efficiency and time. Deflouridation capacity of LECA balls and tamarind gel cover can be analysed. Current investigation showsthat the rate of adsorption is quite high with increase in time.The efficiency of LECA balls for 75 minutes is found to be 80% while the efficiency of tamarind cover for 75 minutes is 62%.

EFFECT OF WEIGHT OF ADSORBENT ON FLOURIDE REMOVAL EFFICIENCY

shows that the flouride removal efficiency of flouride at different weights of adsorbent. are graphs plotted with efficiency and weights of adsorbent. Deflouridation capacity of LECA balls and tamarind gel covercan be analysed. As the weight of adsorbent dose increased the sorption percentage also increased. This might be due to the fact that at higher doses of adsorbent, more sorbent surface and pore volume would be available for the adsorption interaction and this result in higher removal. It was also observed that, initially, the removal of fluoride increases with the dose but beyond certain dose range, there is no significant increase in removal. This perhaps is due to non-adsorbability of fluoride ion as result of sorbent-sorbate interaction. Results shows that the LECA balls has maximum efficiency of 79% and tamarind cover has maximum efficiency of 64 %.

EFFECT OF pH ON FLOURIDE REMOVAL EFFICIENCY

The adsorption was found to be sufficiently influenced by the pH of the medium.Table 4.5 and 4.6 shows that the flouride removal efficiency of flouride at different pH. Figure 4.5 and 4.6 are graphs plotted with efficiency and pH. Deflouridation capacity of LECA balls and tamarind gel covercan be analysed The effect of pH change on the defluoridation was carried out within a range of pH 2 - 10. Maximum removal was observed around neutral pH (around neutral pH, the surface will be positively charged columbic interaction between fluoride ion and adsorbent surface was higher).

In the acidic pH range, the amount of fluoride adsorbed slightly decreased and this can be attributed to the formation of weak hydrofluoric acid. In alkaline pH range, there was sharp drop in adsorption which may be due to the competition of the hydroxyl ions with the fluoride for adsorption.

CONCLUSIONS

Most of the countries depends on the groundwater as drinking water. Fluorosis is an important public health problem in India due to fluoride contaminated drinking water. The first and foremost preventive measure of fluoridefree drinking water supply can be accomplished by defluoridation of potable water. Evidently, the cheapest and abundantly available adsorbents have demonstrated outstanding removal capabilities for fluoride removal and can be exploited commercially, contributing to the sustainability of the environment.

Following conclusions are recorded

- Our proposed surface modified LECA has provided better removal efficiency than tamarind gel cover.
- The adsorbent media after three consecutive usages, have to be replaced with fresh adsorbent.

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- The regeneration of adsorption media is not recommended since the LECA balls and tamarind cover are cost efficient material and will not pose any threat to environment while it is disposed off as solid waste.
- Efficiency is increased by increase in weight of adsorbent. Adsorption capacity is greatly influenced by contact time.
- Treated biosorbents are locally available and hence involve no expenditure on transportation and have a very low cost for pretreatment.
- There is no need to regenerate the exhausted treated biosorbents as they are available abundantly, easily, cheaply and locallyFlouride removal is favoured at neutral pH

From the results, it is clearly seen that our proposed Defluoridation technique provides a great difference in Fluoride level in samples before and after treatment. The experiment provides the comparison of fluoride removal efficiency of tamarind cover and LECA balls from a solution contaminated with 10 mg/l fluoride under variable experimental conditions such as contact time, pH and weight of adsorbent.Deflouridation capacity of LECA balls and tamarind gel cover can be analysed. Current investigation shows that the rate of adsorption is quite high with increase in time.The efficiency of LECA balls for 75 minutes is found to be 80% while the efficiency of tamarind cover for 75 minutes is 62%.

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