Defluoridation studies using activated carbon prepared from '*Tridax procumben*' plant

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Abstract— Important factors to be considered for a water source to be used for drinking purpose are its bacteriological quality and presence of certain inorganic constituents like arsenic, lead, fluoride etc. In the 1950s, dentists believed that fluoride was a "nutrient." A nutrient is a vitamin or mineral that is necessary for good health. Fluoride is a commonly occurring toxic mineral in ecosystem. Fluoride enters the aquatic system in the dissolved form through the industrial discharges, from aluminum industries, phosphate industries, coal plants etc, and leads to many diseases and disorders. It is essential that the contaminated water should be treated before being consumed. Hence, in the present project work, an attempt is made to remove fluoride by adsorption using activated carbon prepared from *Tridax procumbens* as adsorbent media.

Index Terms—Fluoride, Defluoridation, *Tridax procumbens*, Activated carbon, Data logging Spectrophotometer,

1 INTRODUCTION

The element fluoride belongs to the 7th group of periodic table called halogens.The salts containing the fluoride elements are found in the seawater and these reacts with metals to form typical salts such as sodium fluoride. Due to high chemical reactivity, they are never found free in nature.

Fluoride occurs wide spread in the lithosphere as a component of rocks and minerals. Earth's crust contains abundant fluoride as in high calcium granite (520mg/l), low calcium granite (850mg/l), alkaline rocks (1200-8500mg/l), shale (740mg/l),sandstone (270mg/l), deep sea clay (1300mg/l) and in deep sea carbonates (540mg/l).

India is considered to be one of the richest countries in the world for the occurrence of fluoride bearing minerals. Abnormal level of fluoride in water is common in fractured hard rock zone with pegmatite veins. These veins are composed of minerals like topaz, fluoride and fluorapatite. Fluoride replaceable hydroxyl ions in ferromagnesium silicates.

Most fluorides are sparingly soluble and are present in natural waters in small amounts. Due to highly electronegative characters it forms only fluorides and no other oxidation states are found in natural waters. In low pH water, the species found in water is high fluoride. With aluminum, bryllium and iron (III) it forms strong complexes. The fluoride ion has the same charge and radius as OH. Hence they can replace each other and can form series F-OH complex with metals. In the acid medium fluoride could well be associated with silica in six co-ordinate or four co-ordinate structure, though rarely.

India is one in 21 nations with serious health problem due to consumption of Fluoride contaminated drinking water. 16 states, of the 32 total states in India are affected [26]. The quality of fluoride dissolved or precipitated is also dependent on the presence of other electrolytes in the aqueous solutions, which are partially ionized. This may be one of the reasons for calcium granite having low fluoride content. The large differences in the fluoride content of source rock and the soil indicates that much of fluoride is lost during the soil formation. It is observed that the most of the insoluble fluoride in the rocks continues to remain insoluble in soils. But most of the soluble fluoride is leached to the soil and lost by getting co-precipitated with calcium carbonates, while part of fluoride enters the clay minerals, which are removed as fine suspended particles in water and only an insignificant portion of the fluoride occurs in the form of soluble fluoride ion in natural water.

According to the guidelines published by WHO, fluoride is an effective agent for preventing dental caries if taken in optimal amounts. But a single optimal level for daily intake

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cannot be agreed because the nutritional status of individuals, which varies greatly, influences the rate at which fluoride is absorbed by the body. A diet poor in calcium, for example, increases the body's retention of fluoride. Water is a major source of fluoride intake.
Fluoride ions from these minerals leach into the ground water and contribute to high fluoride concentrations. Occasionally, mica group of minerals like muscovite and biotite also contributes to water fluoride content.

2 MATERIALS AND METHODOLOGY

2.1 Materials

Tridax procumbens (shown in figure-1) has been in use in India for wound healing, anticoagulant, antifungal and insect repellent. It is also used as medicine in treatment of diarrhea and dysentery. Its leaf extracts were known to treat infectious skin diseases in folk medicines. It is a well-known ayurvedic medicine for liver disorders or hepato-protective nature besides gastritis and heart burn.It is used as treatment for boils, blisters and cuts.The study had found anti-cancer properties of Tridax procumbens against human prostate epithelial cancer cells. It also exhibits anti-diabetic properties.

Figure-1: *Tridax procumben* flower

METHODOLOGY

2.2 EXPERIMENTAL PROCEDURE

2.2 (a) Preparation of activated carbon

1. Collection of Tridax procumbens from site.
2. Thoroughly cleaning the plant.
3. Place it in muffle furnace (Figure-2) at a temperature of 440^0 c for 120minutes.
4. After it has been dried off completely, add 25% by volume of concentrated Sulphuric acid.
5. And again it is kept in the furnace for 30min with a temperature of 440^0 c
6. The product obtained is activated carbon prepared from Tridax procumbens.
7. The activated carbon for stem and flower are prepared separately for experimental study.

Figure-2: Muffle furnance

2.2 (b) Preparation of Synthetic fluoride sample

1. Measure a known amount of NaF (Sodium fluoride).
2. Add the NaF weighed into 1 litre of distilled water
3. Stir it well and allow it to settle for specified time.
4. Measure the initial concentration of fluoride in the sample using Data logging spectrophotometer (Figure-3)

Figure-3: Data logging spectrophotometer

2.2 (c) Test Procedure

1. Take a known quantity of synthetic sample and add a known amount of the activated carbon to the sample and mix well.
2. Allow it to settle for known time, and pipette out 10ml of sample without disturbing the suspended matter into a test tube.
3. Add 2ml of SPADNS reagent and mix it well.
4. Test the sample for the fluoride concentration using data spectrophotometer.

3. RESULTS AND DISCUSSIONS

The experimental study was planned in three phases with suitability, varying dosage of activated carbon and also varying quantity of synthetic sample. Batch experiments were performed.

PHASE -1

The phase 1 study was mainly focused on the suitability of activated carbon made out of Tridax procumben plant. However, the activated carbon was prepared by using stem and flower separately to asses the effects.

1. In the first phase of study, 0.050gm of NaF was dissolved in 2 litres of distilled water to have synthetic sample and the initial concentration of fluoride was measured and it was found to be 2.10mg/L.
2. 0.15 gm of activated carbon prepared out of stem and flower was added to each of 100ml synthetic sample taken and mixed well.
3. In addition a mixture of activated carbon of both stem and flower was also taken in equal proportions for fluoride removal study.
4. From the results obtained as seen in table 1, it is clear that activated carbon with flower is found to increase the concentration and it was checked again with the combination of stem and flower.
5. However, it is clear that activated carbon made out of stem started giving reduction in fluoride concentration and also it is clear that stem portion of the plant is suitable for adsorption and also more the detention time, better is the removal of fluoride.

Activated Carbon	Fluoride Concentration mg/L	Percentage increase / decrease
Stem	1.63(3hr) 1.45(1day)	22.38%(Decrease) 30.95%(Decrease)
Flower	2.23	5.82% (Increase)
Both	2.17	3.22%(Increase)

Table 1. Results obtained in the first phase of study

From the results obtained above, it is evident that, the activated carbon made out of flower was giving increase in concentration of fluoride and it was proven again with the combnation of flower and stem. However, the stem part of the plant is suitable and it was considered for further studies.

PHASE -2

Based on the results obtained in the phase 1 study, it was decided to have the activated carbon prepared out of stem only for further evaluation.

1. In the second phase of study 0.025gms of NaF was dissolved in 1 litres of distilled water, but quantity of synthetic sample taken was 300ml.
2. However 0.45gms was added to 300ml of sample to study the continuous performance @ 3hrs interval.

The following are the results obtained and are shown in table

Time interval	300ml (in mg/L))l	Percentage removal for 300ml
@ 3:00 pm	-	-

@6:00pm	0.01	92.52%
@9:00pm	0.33	84.28%
@12:00am	0.28	86.67%
@3:00am	0.40	80.95%
@6:00am	0.41	80.47%
@9:00am	0.32	84.76%
@12:00pm	0.30	85.71%
@3:00pm	0.20	90.47%
@6:00pm	0.43	79.52%

Table 2. Performance evaluation with respect to time

The plot of percent removal versus time was made and it is clear from figure 1 that, the percentage removal with respect to time was more or less with 80 to 90% range and it was found to be varying with different hours of the day.

4 CONCLUSION

4.1 Conclusion for Phase 1 study:

From the above test conducted, it is evident that by the addition of activated carbon prepared from the plant's stem have the properties to reduce the concentration of fluoride to maximum extent compared to its flower.

By the combination of activated carbon obtained from both flower and stem part of Tridax Procumben proves to be a failure.

From the results obtained it is clear that flower contributes for the increase in concentration of Fluoride and is not suitable for adsorption.

4.2 Conclusion for Phase 2 study:

By the above observation there is significant reduction in the fluoride content at the beginning stages and the trend is well within allowable limit with respect to the change in the time interval.

Future Scope of study

1. Further studies can be done with lesser concentration of activated carbon to arrive at a best dosage.
2. The analysis with respect to field sample can be done with optimum dosage of activated carbon.
3. Alternate herb with similar group of *Tridax procumben* can be tried and adsorption studies can be done.
4. The changes in other physical and chemical characteristics of the water can be studied.

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