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Study of fluoride content in groundwater of Chandrapur region and fluoride removal by adsorption techniques

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Abstract: Groundwater is the most important source of water to meet the requirement of consumption for drinking water, irrigation. India is the largest user of groundwater in the world. It uses an estimated 230 cubic kilometres of groundwater per year - over a quarter of the global total. More than 60% of irrigated agriculture and 85% of drinking water supplies are dependent on groundwater. Fluorine is widely dispersed in nature. It is about
0.06 to 0.09 % of component on Earth's crust and is estimated to be the 13th most abundant element on our planet.

It is the most electronegative of all chemical elements, and as a result, it never exists in elemental form, but rather combines with other elements. Fluoride is distributed universally throughout soils, plants, and animals, and is assumed to be an essential element in animals, including humans. Fluoride has an important role in bone mineralization and formation of dental enamels. Fluoride, when consumed in inadequate quantities (less than 0.5 ppm), causes health problems such as dental caries, lack of formation of dental enamel, and reduced bone mineralization, especially among children. In contrast, when Fluoride is consumed in excess (more than 1 ppm), health problems may result, which equally affect the young and old (WHO 1996). At higher fluoride concentrations, metabolic processes are affected in humans, and overexposed individuals may suffer from skeletal or dental fluorosis, non-skeletal manifestations, or combinations of these maladies
Among the three forms of environmental media (air, soil, and water), groundwater is the major source of fluoride exposure in humans. . To sustain life, freshwater must be continuously available to humans. Throughout history, humans have relied on groundwater as a source of drinking water, and even today, more than half of the world's population depends on sources of groundwater for survival. The levels of natural fluoride that occur in groundwater range from 0.5 to 48 ppm, or more. Common symptoms of fluoride toxicity in humans are stained teeth, paralyzing bone disease, stooped backs, crooked hands and legs, blindness, and other deformities. W.H.O has stated that fluoride should be in the range of 0.1 to 0.5ppm. The Indian Standard for fluoride contents is 1 ppm. This shows that the requirement of fluoride content changes and it depends on the geographical condition and the age of human beings. In this paper we have reviewed various techniques used for removing the fluoride content from the water. India is one among the 23 nations in the world, where fluoride contaminated groundwater is creating health problems. The state of Art Report of UNICEF confirms the fluoride problem in 177 districts of 20 states in India.

Keywords: Fluoride, Groundwater analysis, fluorosis, adsorbents,

INTRODUCTION

Fluoride in an essential constituent for both human and animals depending on the total amount infested or its concentration in drinking water. The presence of fluorine in drinking water, within permissible limits of 1.11 to 1.5 mgd, is beneficial for the production and maintenance of healthy bones and teeth, while excessive intake of fluoride came dental or skeletal which is a chronic disease manifested by mottling of teeth in mild cases, softening of‟ bones and neurological damage in severe cases. Chandrapur being the most polluted city in India (Indian Express, dated - November (2016) hence all the ecological parameter should be checked. Chandrapur city have a large number of coal mines, open cast mines, form alloy plants, thermal power station. All these leads to a lot of mining work going on, Hence it is inferred that there must be rounded after contamination. Groundwater contamination could be due seepage

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of various metals, ions. Fluorspar is a metallic mineral found in various places in Chandrapur which is the major source of fluoride seepage in ground water. Hence fluoride content analysis for Chandrapur region is required to be done. Fluoride contamination in groundwater has been recognized as one of the serious problems worldwide. Fluoride is classified as one of the contaminants of water for human consumption by the World Health Organization (WHO), in addition to arsenic and nitrate, which cause large-scale health problems. Various mineral's, e.g., fluorite, biotite's, topaz, and their corresponding host rocks such as granite, basalt, cyanide, and shale, contain fluoride that can be released into the groundwater. Thus, ground water is a major source of human intake of fluoride. Besides the natural geological sources for fluoride in richment in groundwater, various industries are also contributing to fluoride pollution to a great extent. The Industries which discharge wastewater containing high fluoride concentrations include glass and ceramic Production, semiconductor manufacturing, electroplating,coal fired power stations, beryllium extraction plants, brick and iron works, and aluminium smelters. The effluents of these industries have higher fluoride concentrations than natural waters, ranging from ten to thousands of mg/L. The fluoride content in ground water tends to increase due which heavy withdrawal of water for agriculture purpose, poor recharging, low rainfalls and pollution from industrial effluents. India has declared fluorosis as an epidemic and has banned the use of water for drinking and cooking if the fluoride content is more than 1.5 mp/L. In this project work, we are trying to understand the techniques of removing fluoride using various absorbent.

and welfare Scarcity of pure water is well known. The water may be polluted by natural sources or by industrial effluents. We can say healthy environment is the cost of healthy life. If the quality is sufficiently degraded, it becomes unusable and the effect is the same as a quantitative loss. The control of water quality has become overriding consideration in providing adequate water supplies or continuous use. The World Health Organization (1996) has set a guideline value of 1.5 mg/I as the maximum permissible level of fluoride in drinking waters. However, it is important to consider climatic conditions, volume of water intake, diet and other factors in setting national standard for fluoride. As the fluoride intake determines health effects, standards are bound to be different for countries with temperature climates and for tropical countries, where significantly more water is consumed, continued global growth, health.

LITERATURE REVIEW

1. **M. Bhatnagar et al., (2002)** have studied algal biomass which was pretreated with Ca2+ and used for defluoridation. They got 96% efficiency for removal of fluoride as calcium was attracted by fluoride ion.
2. **Fan et al. (2003**) studied fluoride adsorption on to a number of minerals such as fluorite, calcite, quartz, iron activated quartz and compared their fluoride uptake capacities. Fan et al. (2007) took advantage of the extremely sensitive analysis available for the radioisotope ^{18}F (10^{-13} mg) to look closely at the deposition of fluoride on calcite, hydroxyapatite and fluorite along with quartz and iron (III)-activated quartz from very dilute solution (0.025–6.34 ppb). Their experimental data suggested that among the selected materials, calcite is a surface fluoride adsorbent within that low fluoride concentration range and less effective than all the other solids except untreated quartz. The fluoride did not appear to exchange with carbonate beyond an initial surface reaction.
3. **S.Sivabalan et al., (2003)** prepared activated carbon from cashew nut sheath. The removal of fluoride is more with fine variety of carbon rather than the course. The study indicates that removal of fluoride from aqueous solution depends on pH, contact time, particle size and dose of adsorbent. The adsorption of fluoride from aqueous solution with cashew nut sheath and commercial activated carbon conforms to a Freundlich equation based on the formation of mono layer.
4. **S. Sinha et al., (2003)** used Eichhornia crassipes, commonly known as water hyacinth, for the removal of fluoride from aqueous solutions. Activated carbons at two different btemperatures (carbon0 activated at 300 and 600 C) were prepared using Eichhornia 0 crassipes. The uptake of fluoride was found to be higher (72–98%) on H-type carbon (activated at 600 C) than on L-type carbon (51–93%) and was also higher than non-carbonized plant.
5. **H.S.Parmar et al.,(2006)** investigated adsorption of fluoride on untreated and aluminium chloride/calcium chloride treated corn cobs powder .Untreated powdered corn cobs did not show remarkable adsorption but aluminium treated corn cobs (Al-ccp) had good adsorption capacity. Effective pH range for the fluoride adsorption was found to be 5.0–6.5 and all the experiments were carried out at pH ca. 6.5. The breakthrough fluoride capacity was found to be 18.9 mg/g and 15.12 mg/g for Ca-ccp with Al-ccp, respectively, at initial fluoride concentration of 12.60 mg/L. The fluoride was found to leach out up to 25% using 0.1 M NaOH. The experimental results revealed that leaching of Ca2+ and Al3+ was negligible.
6. **Mohan et al., (2007)** used algal Spirogyra IO2 for fluoride removal from aqueous phase. The extent of fluoride sorption on the algal sorption system showed a marked decrease as the pH of the solution increased from 2.0 to 10.5. The fluoride sorption efficiency at pH 7.0 was found to be 54%. The Langmuir adsorption capacity for fluoride was observed to be 1.272 mg/g. The FTIR results of the fluoride adsorbed Spirogyra IO2 exhibited the participation of surface functional groups associated with hydrogen atoms in the carboxylic groups in sorption interaction.

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MATERIAL AND METHODOLOGY

Introduction

Materials are collected locally. The main objective of the project is to make use of locally available cheap products for removal of fluoride from water. Hence Tulsi, Moringa seeds, used and pottery clay collected and tested. 3.2 Collection and preparation of Adsorbents 3.2.1 Tulsi leaves Tulsi leaves plucked from the plant. Washed with the tap water and dried at roomtemperature without exposure to sun. Grinded in the mixer and sieved from a 600 micron stainless steel sieve.

Collection and preparation of Adsorbents

Tulsi leaves

Tulsi leaves plucked from the plant. Washed with the tap water and dried at room temperature without exposure to sun.Grinded in the mixer and sieved from a 600 micron stainless steel sieve

Fig Grinded Tulsi leaves

Moringa Seeds

Moringaoleifera (Drumsticks) washed with tap water, peeled off to take out
the seeds. The seeds dried at room temperature without exposure to sun. Grinded in the mixer and sieved from a 600 micron stainless steel sieve.

Fig Drumstick [a)whole b) Seeds c) Grinded

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Pottery Clay

Pottery clay collected from a local pottery maker. All the lumps removed from the sample and manually tamped for uniformity of clay. Dried in the sunlight.

PROPOSED WORK

In the proposed work to study the adsorptive properties of Tulsi (Holy Basil), Moringa Seeds and Pottery Clay on the basis of effect of concentration, temperature,adsorbent dosage and contact times.

a) Survey will be carried out generally fluoride containing ground water in Chandrapur Region.

b) Extensive traveling out to each and every place to study the ground water generated and there treatment problem.

c) Specific areas will be identified for the study for example, River, Well, Bores, Lakes, etc.

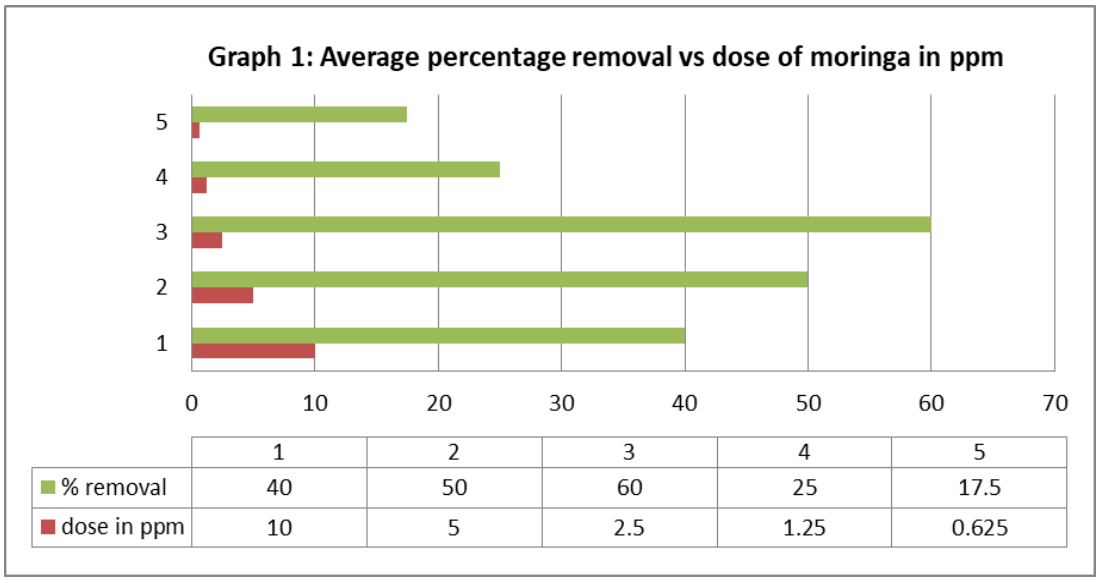
d) Representative ground water samples will be collected from selected area.

e) Analysis will be carried out for Physio-Chemical and biological parameters.

RESULTS AND DISCUSSION

Fluoride is the most sought after mineral in water. The main problem with the fluoride is that very low amount as well as very high amount of fluoride present in water leads to serious health hazards to human as well as to animals. It is like a two way sword which needs to be handled very cautiously. The safe amount of fluoride recommended by various state run organizations is different. Hence it is not very clear about the exact amount of fluoride which is actually beneficial for the intake.

In this project various natural low cost adsorbent were tested for the removal of the fluoride from the groundwater. The following graph shows the average percentage removal of fluoride using various natural adsorbent



	1	2	3	4	5
% removal	40	50	60	25	17.5
dose in ppm	10	5	2.5	1.25	0.625

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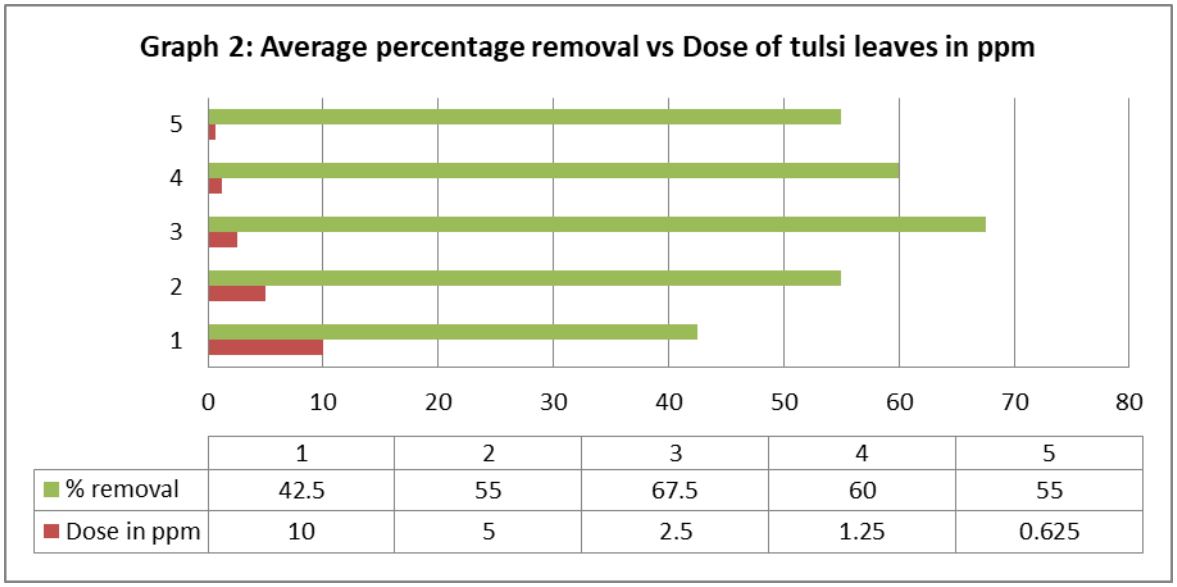
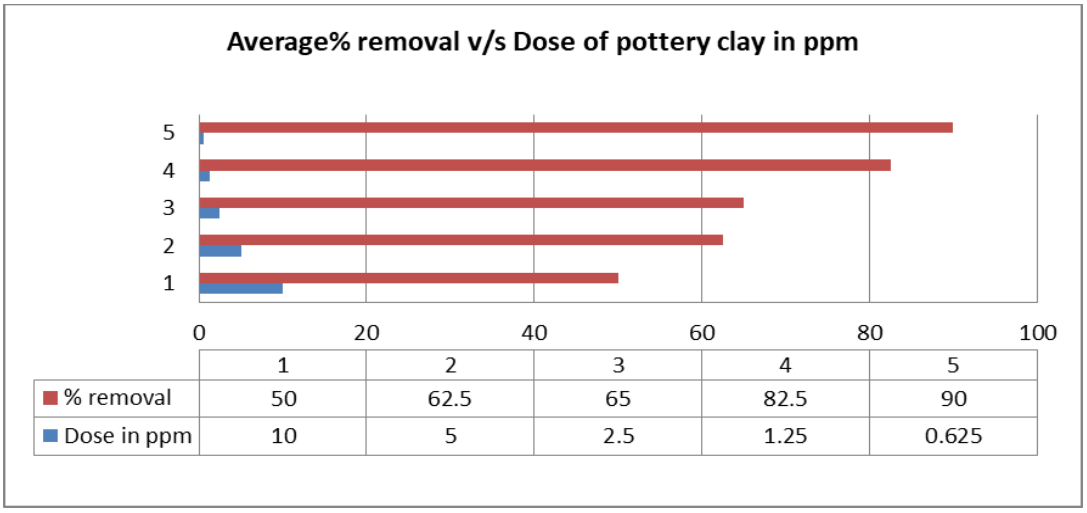
Graph 1: Average percentage removal vs dose of moringa seed in ppm



	1	2	3	4	5
% removal	42.5	55	67.5	60	55
Dose in ppm	10	5	2.5	1.25	0.625

Graph 2: Average percentage removal vs Dose of tulsi leaves in ppm



	1	2	3	4	5
% removal	50	62.5	65	82.5	90
Dose in ppm	10	5	2.5	1.25	0.625

Graph 3: Average percentage removal vs Dose of Pottery clay in ppm

The graphs which are plotted show the key relation between the dose of various adsorbent and % removal of the fluoride. These graphs are helpful in understanding the optimum dose of adsorbent to be added for the removal fluoride from the water. The optimum dose for the various adsorbent tested is as follows

Sr.no	Adsorbent	Optimum Dose
1	Moringa Seeds	2.5 mg/lit
2	Tulsi	2.5 mg/lit
3	Pottery clay	0.75 mg/lit

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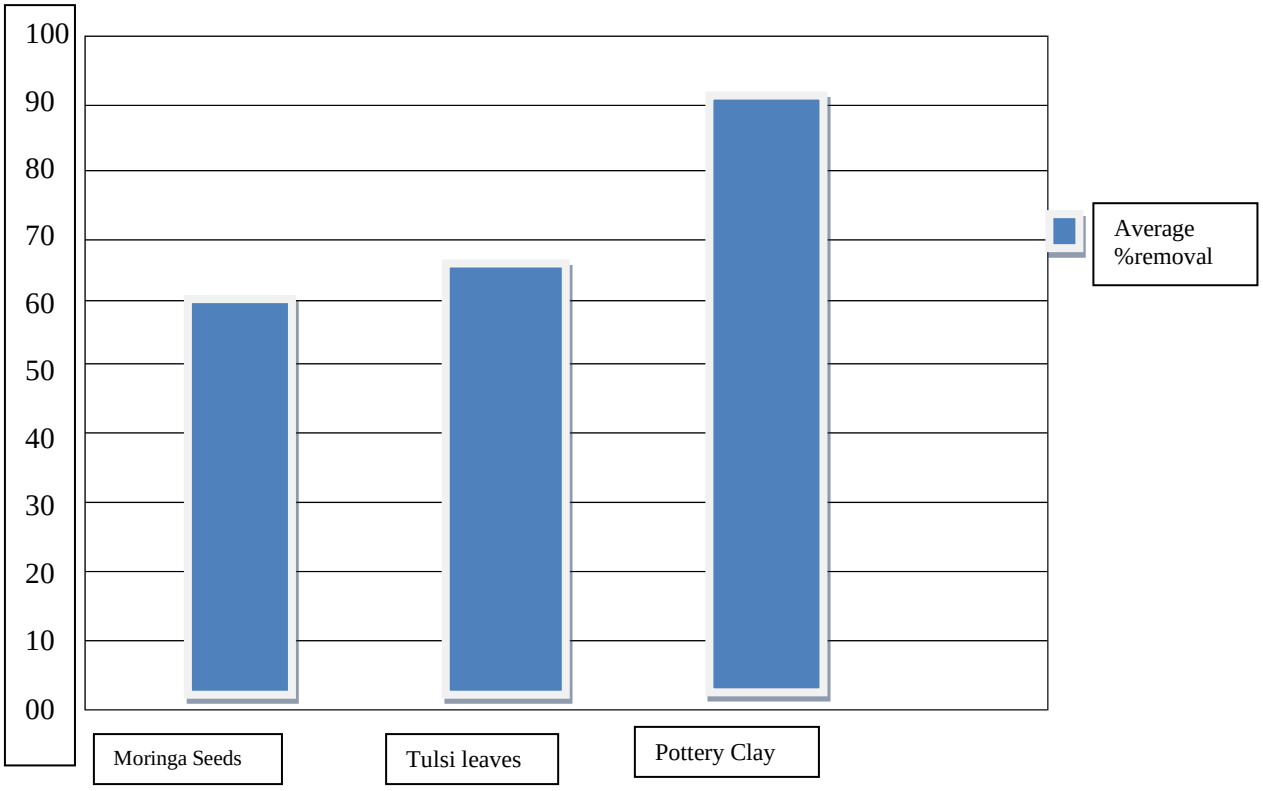
Graph: Comparing % removal of various adsorbent



CONCLUSION

- The main objective of the project is to provide a adsorbent which locally available as well as cheap innature. Hence various adsorbents have been tested hereby.
- From the study it can be stated as, low cost bio-adsorbents can be effectively used for removal of fluoridefrom water.
- Moringa Seeds (drum sticks), Tulsi, Tea leaves, Pottery clay all these have shown good fluoride removal capabilities. As discussed in the result section the pottery clay have shown the best result among the others.
- From the various adsorbent tested, it can stated that removal of fluoride depends upon the surface area of adsorbent. The more the surface area, more will be removal. As surface area increases removal efficiency increases.

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