

PHYSIO CHEMICAL ANALYSIS OF GROUND WATER USING NATURAL ADSORBENTS

Submitted in partial fulfilment of the requirements for the award of

Bachelor of Engineering degree in

Civil Engineering

By

M.KANNAN-37200031

J.LIJIN JOHN-37200034



**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT**

**SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

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Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai – 600 119

www.sathyabama.ac.in



DEPARTMENT OF CIVIL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **M.KANNAN(37200031)** and **J.LIJIN JOHN(37200034)** who carried out the project entitled **“PHYSIO CHEMICAL ANALYSIS OF GROUNDWATER USING NATURAL ADSORBENTS ”** under our supervision from October 2020 to April 2021

Internal Guide

Mrs. S. VANITHA M.E.,

Head of the Department

Submitted for Viva voce Examination held on_____

**Internal Examiner
Examiner**

External

DECLARATION

We **M.KANNAN (37200031)** and **J.LIJIN JOHN (37200034)** hereby declare that the Project Report entitled “**PHYSIO CHEMICAL ANALYSIS OF GROUNDWATER USING NATURAL ADSORBENTS**” done by us under the guidance of **Mrs.S.VANITHA** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Civil Engineering.

1.

2.

SIGNATURE OF THE CANDIDATES

DATE:

PLACE:

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ABSTRACT

Water is of fundamental importance for life on earth. The synthesis and structure of cell constituents and transport of nutrients into the cells as well as body metabolism depend on water. The contaminations present in water disturb the spontaneity of the mechanism and result in long/short-term diseases. Fluorides are the hazardous inorganic pollutants widely present in underground and industrial waste water. High intake of fluoride results in numerous health threat which can be fatal to living beings. Water samples were collected from five areas in and around Perumbakkam to determine the amount of fluoride present .The present work explores a new approach of development in the field of purification of water through minimal energy input, less labour and low investment, also proves to be biodegradable and effective compared to synthetic adsorbent and chemicals. We have employed biosorbption method for effective removal of fluorides from sample using naturally available plant wastes like Mosambi peels, Banana peels and Orange peels. These peels were processed, powdered to increase their absorbtion efficiency. Orange Peel Powder removes 66% of fluoride content with 150 gram adsorbent, followed by Banana Peel powder removes 79% of fluoride content with 150 gram of adsorbent Whereas Mosambi peel powder removes 90% of fluoride from sample solution.

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CHAPTER 1

INTRODUCTION

Water is considered to be a source of life which is essential for all forms of life to sustain the suitability of water can be affected by undesirable materials dissolved in it one such hazardous inorganic contaminant is fluoride. Excessive presence of fluoride in potable water continues to be a serious public concerns in India, 25 million people have already been affected and another 66 million at risk including 6 million children below the age of 14 years by fluoride contamination. Unsafe drinking water results in 90% of all deaths in children below five years old as a result of fatal disease.

Fluoride is a naturally occurring compound derived from fluorine. Fluoride is Physiologically move active ion which forms water soluble salts with monovalent cation like NaF and KF and form insoluble salt with divalent cation like CaF_2 . Fluoride enters into ground water through geogenic factors like igneous granite and sedimentary rocks like fluorite, cyolite, phosphorite, theorapatite etc, leaching at aquifer bottom. Anthropogenic sources like industrial effluent, fertilizers pesticides, fluorosilicone and fluorocarbon polymer synthesis, coke manufacturing, glass and ceramic manufacturing, electronics manufacturing, electroplating operations, steel and aluminium manufacturing, metal etching and wood preservation. The fluoride content in the ground water is a function of many factors like availability and solubility of fluoride minerals, velocity of flowing water, pH, temperature and concentration of calcium and bicarbonate ions in water.

Humans comes in contact with fluorine through numerous sources like food water, air, medicine and cosmetics. Among these drinking water is most common source. World health organization (WHO) in 1963 has recommended that the optimum level of fluoride in drinking water should not exceed 1.5mg/L beyond this level considered as threat to human. Fluoride is a micronutrients which is often called as two edge sword i.e it has both beneficial and detrimental effects, like

small doses (1-1.5mg/L) will strengthen bones and enamel of teeth. High doses (above 1.5mg/L) leads to the life threatening complications.

ADVERSE EFFECTS OF FLUORIDE:

Dental fluorosis is the most common complication caused by the usage of high- fluoride water (>4mg/L) which is characterized by discolored, blackened, mottled or chalky white teeth. Skeletal fluorosis occurs due to long time consumption of high-fluoride drinking water leading to several and permanent bone and joint deformation. Fluoride ion is attracted by positively charged calcium ion in teeth and bone due to its strong electronegativity, results in fluorosis. There is no cure for fluorosis. Fluoride is a neurotoxin. Fluoride causes reduced intelligence, impaired memory and decreased IQ level.

The human placenta does not prevent the passage of fluoride from a pregnant mother's blood stream to fetus. So the fetus can be harmed by fluoride ingested pregnancy which affects fetus brain development.

Fluoride binds with functional amino acid groups located around the active center of an enzyme to cause an inhibitory effects which leads to disease enzyme activity. Various diseases like kidney disease, DNA damage, bladder cancer, osteoporosis, arthritis, brittle bones, infertility, brain damage, and Alzheimer syndrome and thyroid disorder are caused by excess ingestion of fluoride.

The only possible remedy for all these problem is defluoridation. Adsorption is a physical process where dissolved contents adhere to the porous surface of the solid particles. It is the surface phenomena and the outcome of surface energy. With the material, all the bonding requirements of the constituent atoms of the material are filled with other atoms. However, atoms on the surface of the adsorbent are not wholly surrounded by other adsorbent atoms and physical attractive force results. It can be physisorption (originates from vanderwaals forces) and chemisorption (originates from co-valent forces). Adsorption has shown considerable potential in defluoridation. The viability of such techniques depends on the development of suitable adsorptive material. Bioremediation is recognized as a cost-effective friendly option for cleanup of fluoride and

environmental contaminated water. Nowadays biosorption method is very effective technique for removal of fluoride form water.

This technique involves low cost bioadsorbent. This method is preferred at community and household levels in rural areas because of its low cost and ease of operation, high efficiency, easy accessibility, environment benignity and needlessness of operational skill and electric power to run and since adsorbents can be reused and recycled making it ideal for use in less-development rural areas. It has the added advantage that can be applied to a decentralized water supply system. The availability of large amounts and low costs make them potential candidates for the defluoridation in remote areas.

Fruit peels have attracted considerable interest as potential candidates for removal of pollutants from aqueous solution due to their inexpensiveness, availability, environmental stability and high surface area absorption capacity. Among we have chosen peels of fruits like banana (*Musa acuminata*), orange (*Citrus X sinensis*), and mosambi (*Citrus limetta*) as our biosorbent because they are widely consumed and their peels constitute large amount of bio waste. They also contain many biomolecules with active functional groups which binds with fluoride results in portable water for human consumption.

CHAPTER 2

LITERATURE SURVEY

2.1 GENERAL

The main purpose of literature survey is to give an idea about the research and knowledge of the research conducted in depth, this forms the base on which one can carry out the work and techniques that can be used for finding runoff. The following literature survey describe the research studied made on Physico chemical analysis of ground water using natural absorbents.

2.2. LITERATURE REVIEW

Aakanksha Darge and Mane (2013) found out Biosorption as a recent eco-friendly technique which gained importance in this decade. The process of Biosorption has many attractive features compared to the conventional method. The present study investigates that successful use of eco-friendly adsorbents like Banana peels and Fish scales. Banana peels and fish scales were washed, dried and ground to 150- 200 μm and to 160 μm respectively, before being used for treatment of pharmaceutical waste water. The combination of both these biosorbent was used for treatment of waste water with different proportion of adsorbents, variation of pH and contact time. . Waste water sample of 500ml each was kept with 1.0gm of fish scale and banana peel, powdered as an adsorbent, in orbital shaker at 150 to 180 rpm at 25°C. Then the separation of bioadsorbent and solution was carried out by filtration with Whatman Filter Paper No.42 and the filtrate stored in sample cans for determine the metal ion concentration using Atomic Absorption Spectrophotometer (AAS). An experiment is carried out by different concentration of dosage for incubation time 24 hours. Heavy metal ions were estimated before and after addition of powdered adsorbents. It is found that the maximum efficiency of removal of heavy metal by this method is 60% and 70% respectively

Achla Rani et al. (2018) used powdered mosambi peel powder as an adsorbent to remove fluoride. Effect of various parameters like effect of contact time, effect of initial fluoride concentration, effect of adsorbent dose, effect of pH on rate of adsorption has been studied. Equilibrium and kinetic study of adsorption has also been studied. Equilibrium study proves that freundlich isotherm fits for this adsorption and kinetic study shows that adsorption follows Pseudo second order reaction. Maximum adsorption of fluoride was found at pH=6, in the 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.

A.Hussen (2016) the present study shows that thermally treated adsorbent prepared from coffee husk and banana peel are suitable for the removal of fluoride ions. The operational parameters such as adsorbent dose, contact time, pH, and initial concentration were found to have an effect on the adsorption efficiency. The adsorbents prepared from banana peel and coffee husk exhibited highest removal efficiency of 85% and 86%, respectively, for 10 mg/l of initial fluoride concentration. Application to real water sample also resulted in removal efficiency ranging from 80 to 84 %, In terms of time and adsorbent dose required, coffee husk was observed to be much effective than banana peel.

Christina and Viswanathan (2015) prepared immobilized saponified orange peel residue (SOPR) in alginate matrix and then matrix was loaded with 5% of $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ where the composite adsorbent was referred as FSOPR and used for removing fluoride from water. The equilibrium adsorption information fitted well with the Langmuir isotherm model and pseudo-second-order kinetic model. The maximum adsorption capacity of FSOPR was 7 mg/g. Defluoridation process took place by electrostatic interaction and ion exchange mechanism. The fluoride uptake was mostly due to attraction of hydroxide and carbonyl groups with fluoride ions. The author used green waste of orange peel for effective removal of fluoride from aqueous solution.

Deepankar Dev Pandey et al. (2016) used mosambi peel as a bisorbent for removal of fluoride from industrial waste water. These peel powders were characterized using SEM and EDAX. The fluoride removal efficiency of mosambi peel was investigated by batch wise adsorption experiment. Adsorption of fluoride on to Mosambi Peel followed the pseudo second order rate equation. The effect of various important parameters on the % removal was studied to find the optimum condition for the maximum removal of fluorides. The parameters like contact time, adsorbent dose, initial fluoride concentration and pH were investigated. The optimum pH, initial concentration, adsorbent dose and contact time were found to be 7, 20 mg/l, 10g/l and 40 min. The kinetic data was best fitted with Bangham's model with good correlation coefficient (0.9854) which shows that the adsorption mechanism is controlled by pore diffusion process. At optimum conditions, the value of these parameters was 7, 40 minute, 20 mg/l and 10g/L respectively for which the removal efficiency was maximum i.e. 94.23%

Dipankar Thakuria et al (2016) worked on Removal of iron and fluoride from groundwater using the process of adsorption. The experiments were performed on various parameters like dosage of adsorbent, pH, temperature and contact time to check their influence on adsorption. Adsorbent dosage of 4.7 g/50 ml at pH 5, temperature of 20°C and contact time of 420 minutes were considered as optimum. The adsorbents were prepared and cleaned before using as adsorbent. They were kept in contact with 0.1 N HCl at 20°C at 120 rpm for 24 hours in an orbital shaking machine. After 24 hours they were filtered and dried in an oven at 105°C again for 24 hours.

Dwivedi et al. (2014) have investigated the defluoridation capacity of Citrus Limetta (Mosambi) peel powder in a batch reactor. The experimental data fitted well for pseudo-second-order kinetic model and Freundlich isotherm model ($R^2 = 0.996$). The maximum Langmuir adsorption capacity of mosambi peel powder was 1.82 mg/g. The fluoride uptake increased from 0.089 mg/g to 1.35 mg/g with an increase in initial fluoride concentration from 1 mg/L to 20 mg/L. The fluoride removal of adsorbent was 82.5% when the initial fluoride concentration of the water

was 5 mg/L. Thus 0.9 mg doses of adsorbent was responsible to bring down the fluoride concentration of 5mg/L to less than 1.5 mg/l as per WHO standard for drinking water.

Gandhi et al (2012) conducted a study on adsorbents such as concrete, ragi seed powder, red soil, horse gram seed powder, orange peel powder, chalk powder, pineapple peel powder (PPP), and multani mitti. The experimental setup was bath studies. Result indicated fluoride removal efficiency of 86% for chalk powder and pineapple peel powder. Seventy-nine percentage and 75% for horse gram seed powder and 80% for orange peel powder. Percentage removal for ragi seed and red mud was found to be 65% and 71%. Removal efficiency was recorded less for multani mitti and concrete which was 56% and 53%.

Jha et al. (2015) used zirconium (IV) loaded carboxylated orange peel (ZCOP) for defluoridation from drinking water. The fluoride removal was achieved over a wide pH range of 3.0-8.0. The maximum removal of 97.2% was attained at pH 7 with 0.7 g/l doses of adsorbent, contact time of 50 min for initial fluoride concentration of 10mg/l. The adsorption data were well described by D-R isotherm model. The Langmuir maximum adsorption capacity was 5.605 mg/g at pH 6.0. The adsorption process followed the pseudo-second-order kinetic model. The adsorption reaction was spontaneous and endothermic in nature. The adsorption was governed by an ion exchange mechanism. The fluoride uptake was interrupted by the presence of phosphate and bicarbonate to some extent but nitrate, sulphate and chloride did not affect the fluoride removal efficiency. The reuse of adsorbent showed the fluoride removal of 83%, even in 8th cycle against 97% in 1st cycle. Desorption of 91% of adsorbent was done by 0.1M NaOH solution

Kola Srikanth Reddy et al. (2017) they concluded that among various methods used for defluoridation of water, adsorption method is relatively simple, economical, and appropriate for drinking water treatment, especially for small communities. In this review, they listed numerous adsorbents and their adsorption capacities for fluoride are overviewed with various affecting parameters. The

naturally available adsorbents are horse gram powder, ragi powder, multani mitti, red mud, calcined clay, concrete, pineapple peel powder, chalk powder, orange peel powder, rice husk, Moringa oleifera extract (MOE), gooseberry, activated aluminacoated silica gel, activated sawdust, activated coconut shell carbon, coffee husk, bone charcoal, activated soil sorbent, etc., are some of the different materials investigated for adsorptive removal of fluoride from water.

Mohammad and Majumder (2014) investigated feasibility of three low-cost biomass-based adsorbents, namely, banana peel, groundnut shell, and sweet lemon peel for industrial waste water defluoridation at neutral pH range. The banana peel, groundnut shell, and sweet lemon peel removed 94.34, 89.9, and 59.59% of fluoride, respectively. Contact time for banana peel, groundnut shell, and sweet lemon peel is 60.0, 75.0, and 40 min, respectively, at doses of 14, 12, and 16 g/L, respectively. Action of these adsorbents on fluoride was compared with commercially available adsorbents. It was found to be much better, high removal efficiency at higher concentration (20 mg/L) of fluoride in industrial waste water.

Naba kumar mondal(2017)research was carried out to explore bana peels as a high capacity,economically viable, and low cost adsorbent for removal of fluoride .adsorbent characterizationhas done by Ph,SEM and FT-IR studies. The PH played pivotal on sorbate adsorbtion capacities onto natural banana peel biosorbent the decrease in the PH leads to the significant increase in the adsorbtion capacities of all parameters on banana peel biosorbent with maximum adsorbtion capacity. Therefore the use of banana peel could be a cost effective adsorbent and may provide an alternative method for removal of fluoride from contaminated water

N.G.Telkapalliwar,V.M.Shivankar(june 2016)The review shows that the adsorbtion process has great potential for elimination of fluoride from industrial wastewater using fruit peel and sheel based low cost adsorbents.During this review article, an essay has been made to specialize in the recent developements

associated with fluoride removal by low cost adsorbent utilizing fruit peel and shell based bioadsorbent. More studies should be carried out for low cost adsorption process to promote large scale use of non conventional adsorbents.

Shashank Yadav (2018) the contamination of fluoride in water is profound and emerging technologies are required for removal of it. The present study shows that mosambi peel can act as efficient biosorbent in removal of fluoride from water. The effect of different parameters like contact time, adsorbent dosage, fluoride concentration was studied. The removal efficiency nearly 71% was achieved when 0.5g of mosambi peel powder of 106 micro meter size fraction was used as adsorbent to treat 100 ml of water sample of 200 mg/l fluoride concentration for a contact time of 0.5 h. further study of effect of parameters like pH, temperature and effect of different pretreatment methods of adsorbents would help to increase the efficiency of nitrate removal and enhance the applicability of mosambi peel as a adsorbent

Thomas et al. (2009) studied about the bio sorption of heavy metal ions from aqueous solutions using a biomaterial. The aim of this work is to study the removal of toxic heavy metal ions by Neem leaves from synthetic waste water and to offer this bio sorbent as local replacement for existing commercial adsorbent materials.

CHAPTER 3

AIM AND SCOPE OF THE EXPERIMENTAL WORK

3.1 AIM

The main aim of this experiment is to investigate the effectiveness and efficiency of defluoridation using bio sorbents like banana (*Musa acuminata*) peel powder, orange (*Citrus X sinensis*) peel powder, and mosambi (*Citrus limetta*) peel powder.

3.2 SCOPE

The scope of the project is

- To study the existing water filtration methods and to design a **Low cost water filtration** using **natural adsorbents**.
- To eliminate excessive concentration of Fluoride ion in ground water using natural adsorbent in order to curb the harmful health threats possess by them.
- Critical analysis of selected natural adsorbents used for identification of water purification.

Objective

- Ground water samples were collected from various areas in Perumbakkam.
- Samples are analyzed using sample analysis test to find the amount of fluoride levels are exceeding than other impurities.
- Low cost natural adsorbents like banana (*Musa acuminata*) peel powder, orange (*Citrus X sinensis*) peel powder, and mosambi (*Citrus limetta*) peel powder were collected and processed to obtain desirable results.
- Processed bio sorbents were used for effective defluoridation.

CHAPTER 4

METHODOLOGY

The methodology of the present study is shown in the fig (2), where the flowchart for the study is shown. There are various steps involved in the study. Firstly, ground water samples had been collected for analysis from five different places in Perumbakkam then these samples are analyzed for the components present in it. It was found that the samples contain maximum amount of fluorides with other elements. Since excess amount of fluoride in ground water is considered harmful to human beings. They need to be removed using an adsorbent. Due to environment friendly nature and low cost, bio sorbents are preferred. These bio sorbents are selected based on their availability, low cost and easy access. We have selected natural adsorbents like orange peel, mosambi peel and banana peel which are cleaned and powdered to act as adsorbent. The filtration set up is done using sand and gravel with the peel powder for effective defluoridation. The samples were again analyzed for the presence of fluoride. The adsorbent treated sample was compared with raw sample to know how much of fluoride is being reduced.

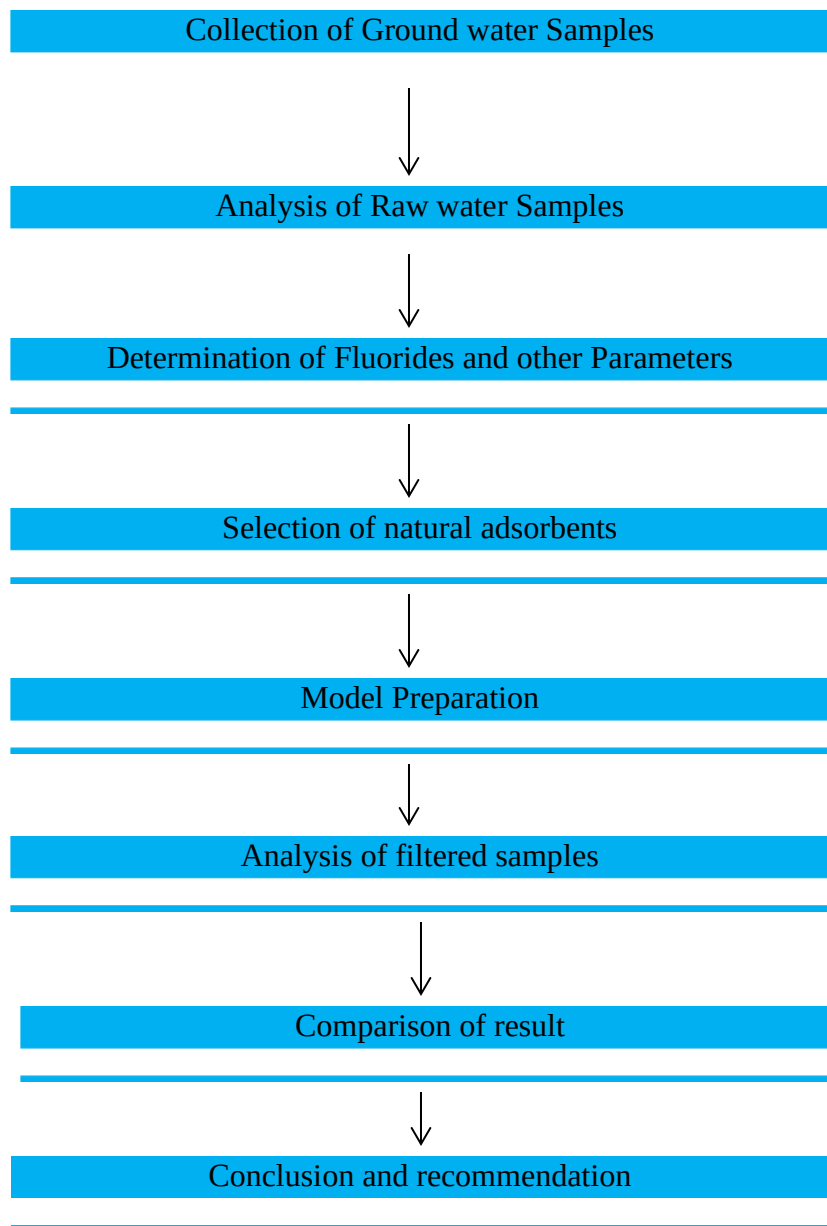


Fig: 3.1: Schematic representation of the Experiment

4.2 COLLECTION OF WATER SAMPLES

- Water samples have been collected according to the availability, for finding their physio-chemical factors.
- Samples are collected from the areas around “PERUMBAKKAM”.
- Water sample were collected in sterile bottles, bottles are rinsed in KMnO_4 . Glass vessels were cleaned by using three step – first used concentrated nitric acid (conc. HNO_3) second step rinsed by ethanol and last step cleaned glass vessels several times double distilled deionized water. All required chemicals were purchased from local market and of laboratory reagent grade.
- The collected water samples are given for testing to know the parameters of water samples and their fluoride content.



Fig: 4.1: water samples collected at 5 different places at Perumbakkam

4.3 RAW WATER SAMPLES COLLECTED FROM FOLLOWING PLACES

- Radha Nagar
- Nethaji Street
- Pallavan Nagar
- Vgp gokul Nagar
- Perumbakkam

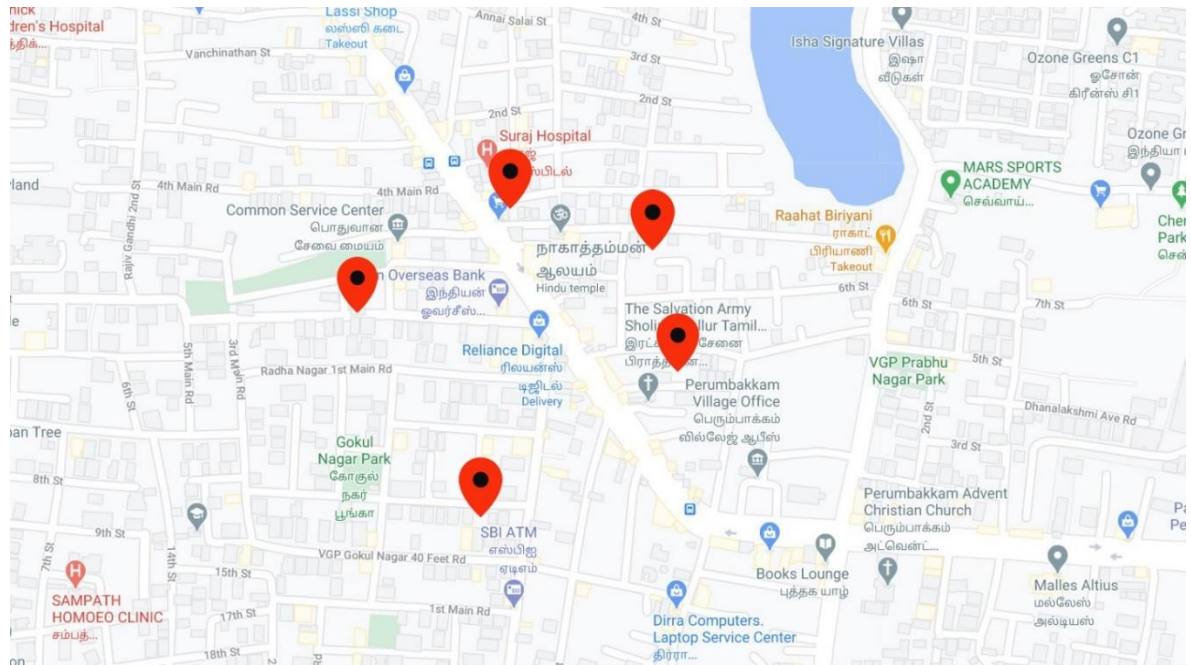


Fig: 4.2: Areas where raw water samples collected

4.4 TESTING OF RAW WATER SAMPLES

Raw water samples have been tested for the following parameters to know the physio-chemical properties of the raw water samples collected from the five different locations around Perumbakkam are

- Appearance

- Colour
- pH
- odour
- Turbidity
- Total Hardness
- Calcium
- Magnesium
- p-Alkalinity
- Total Alkalinity
- Chloride
- Sulphate
- Total Dissolved Solids
- Iron
- Silica
- Carbonate Hardness
- Non Carbonate Hardness
- Maganese
- Lead
- Zinc
- Fluoride

Table 4.1: WHO drinking standards

parameters	Max limit	Mini limit	Desired range
Total hardness(mg/l)	1000	100	500
Turbidity (NTU)	25	0.3	5.0
Iron (mg/l)	1.0	0.2	0.3
Chloride (mg/l)	1200	20	250
Alkalinity (mg/l)	600	200	500
TDS(mg/l)	2500	200	1000
Nitrite (mg/l)	3.3	0.003	0.5
Fluoride (mg/l)	1.5	0.5	1.0

4.4.1 Total hardness of water test

- Hardness, a physico chemical property of water, is generally a measure of

calcium and magnesium ions in water. Zinc, iron, strontium, aluminum, and manganese can also contribute to water hardness; however, they are generally present in very low concentrations. These ions enter a water supply by leaching from minerals of rocks and soil.

- Later, it has been generally accepted that hardness is defined as the sum of the Ca and Mg concentrations, determined by the EDTA complexometric titration method.
- The total hardness of water is estimated by titrating the water sample against Ethylenediaminetetraacetic acid (EDTA) using Eriochrome Black-T (EBT) indicator.
- Hardness of all the water samples was tested by using EDTA-tritrimetric method by taking 50ml of water sample into a conical flask along with 100ml of ammonia buffer solution and 100-200-mg of Eriochrome black- T indicator followed by titration with EDTA solution present in a burette. End point is noted down by changing of the water solution color from wine red to blue
- Initially EBT forms a weak $\text{EBT}\text{Ca}^{2+}/\text{Mg}^{2+}$ wine red colored complex with $\text{Ca}^{2+}/\text{Mg}^{2+}$ ions present in the hard water.
- On addition of EDTA solution, $\text{Ca}^{2+}/\text{Mg}^{2+}$ ions preferably forms a stable $\text{EDTA}\text{Ca}^{2+}/\text{Mg}^{2+}$ complex with EDTA leaving the free EBT indicator in solution which is steel blue in color in the presence of ammonia buffer (mixture of ammonium chloride and ammonium hydroxide, pH 10).

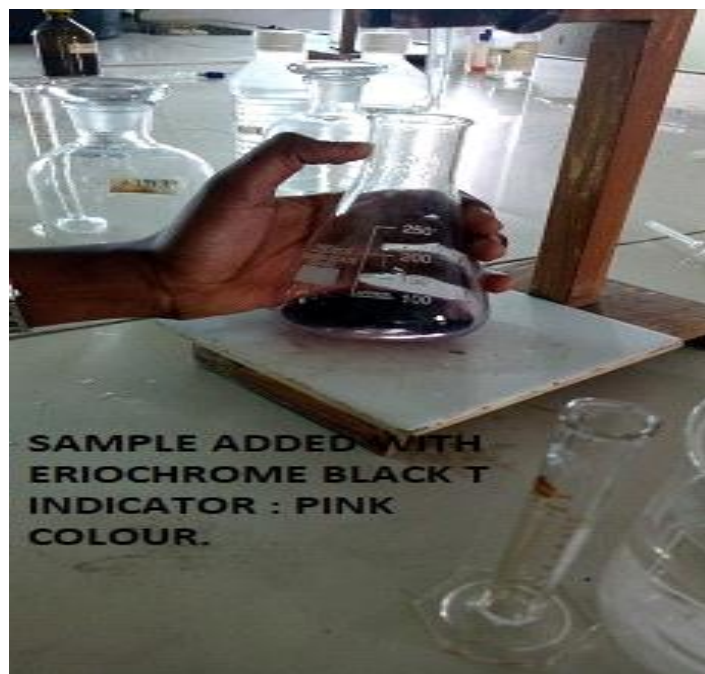


Fig: 4.3: Testing of raw water sample for total hardness of water

4.4.2 Chloride test

- The chloride ion is highly mobile and concentrations in water are not affected by chemical reactions. Hence chloride does not biodegrade, readily precipitate, volatilize, or bioaccumulate. The chloride ion does not adsorb readily onto mineral surfaces and therefore concentrations remain high in surface water and sediment pore water, and low in sediment. High chloride concentration in water are not known to have toxic effects on human although large amount may act corrosively on metal pipes and be harmful to plant life.
- Filter the given water sample so as to remove any suspended material. Pipette out 50 ml of this filtered sample in conical flask and add 3-4 drop of phenolphthalein indicator to it if pink colour just disappear. To the red coloured solution obtained after adding methyl orange indicator add N/50 sodium carbonate solution until the colour of the solution changes to orange.

- Transfer the resultant solution in a 250 ml conical flask and add 1 ml of potassium chromate indicator. Now add slowly standard N/50 silver nitrate solution from the burette with constant shaking.
- A white precipitate of silver chloride will be obtained. Continue the addition process slowly, a red colour will appear in the flask, which disappears on shaking. Now add 0.014N silver nitrate solution drop by drop until a permanent reddish brown colour is obtained.

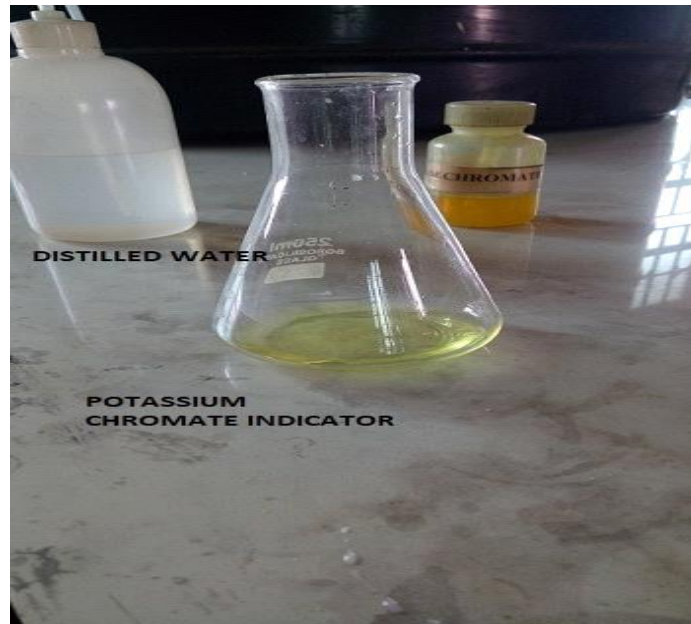


Fig: 4.4: Testing of raw water sample for the presence of chloride

4.4.3 Turbidity test

- Turbidity is the cloudiness of water caused by a variety of particles and is another key parameter in drinking water analysis. Turbidity is a drinking water quality parameter and a groundwater well stabilization indicator. The clarity of water defines a physical property of turbidity. Suspended matter, such as clay and silt particles, organic matter, microscopic organisms, and colloids, causes natural waters to be turbid. Turbidity is measured optically as a light-scattering property of water.

- The water testing kit container is used to perform the turbidity test. Remove the backing from the secchi disk icon sticker.
- Adhere sticker on the inside bottom of the large white jar (kit container) positioned the sticker slightly off center.
- Fill the jar to the turbidity to the line located on the outside kit label. Hold the turbidity chart on the top edge of the jar.
- Looking down into the jar, compare the appearance of the secchi disk icon in the jar to the chart. Record the result as turbidity in NTU.



Fig: 4.5: Sample in the Digital turbidity meter

4.4.4 Alkalinity Test

- The alkalinity of the water is a measure of its capacity to neutralize acids. The alkalinity of natural waters is due primarily to the salts of weak acids. Alkalinity is measured by titrating a sample with acid. Alkalinity in excess of alkaline earth metal concentrations is significant in determining the suitability of water for irrigation. Alkalinity measurements are used in the interpretation and control of water and wastewater treatment processes.

- The burette is filled with standard sulphuric acid to the zero level, following usual precautions.
- 20 ml of the given water sample-A is pipetted out into a conical flask.
- Two drops of phenolphthalein indicator is added and titrated against the standard sulphuric acid.
- The end point is the disappearance of pink color. The titrated value is noted. A drop of methyl orange indicator is added to the same solution after the phenolphthalein end point and the titration is continued until the solution becomes orange.
- The total titrated value is noted. The titration is repeated to get concordant value and the titrated values are noted.

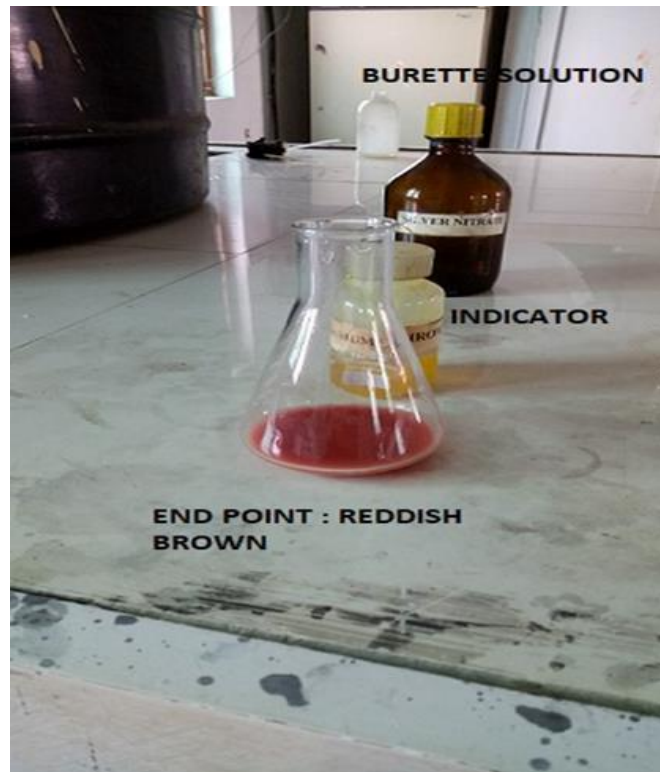


Fig: 4.6: Alkalinity testing of raw water sample

4.4.5 Other parameters

Other parameters like Residual chlorine, Phosphate, Nitrite, Ammonia are tested using end point change in the sample after mixing it with their respective indicator to indicate the presence of the parameter in the raw water samples and the end point is compared with the chart of the respective parameter which indicates the range of the parameter content in the raw water sample used for testing



Fig: 4.7: Test on other parameters

On testing the following parameters in the environmental lab the following report is made on the parameter analysis in the table

Table: 4.2: Results obtained from water sample

Parameters	Sample- 1	Sample-2	Sample-3	Sample-4	Sample-5
Fluoride	1.3 mg/l	1.0 mg/l	1.1 mg/l	1.1 mg/l	1.2 mg/l
Turbidity	1 NTU	1 NTU	2 NTU	4 NTU	1 NTU
TDS	998 mg/l	856 mg/l	348 mg/l	1116 mg/l	952 mg/l
Alkalinity	284 mg/l	410 mg/l	130 mg/l	273 mg/l	189 mg/l
Chloride	318 mg/l	520 mg/l	240 mg/l	314 mg/l	228 mg/l
pH	7.6	7.2	7.4	7.0	6.9
Iron	0.05 mg/l	0.13 mg/l	0.24 mg/l	0.53 mg/l	0.06 mg/l
Hardness	255 mg/l	410 mg/l	130 mg/l	273 mg/l	189 mg/l

4.5 LISTS OF ADSORBENTS

Following are the lists of adsorbents used for the removal of fluoride content are:

- Orange peel powder
- Mosambi peel powder
- Banana peel powder
- Coconut coir (ash-activated carbon)
- Natural zeolite – clinoptilolite
- Rice husk (ash-activated carbon)

The required materials for biosorption of fluoride were collected locally, pretreated to remove impurities, processed and powdered, in order to improve its efficiency of removing the fluoride content from the raw water sample.

4.6 MATERIALS USED AND PREPARATION OF ADSORBENT MEDIA

Large number of scientists and environmentalists has investigated the possibility and efficiency of utilization of the natural adsorbents for heavy metal adsorption in polluted water due to their cost efficiency and eco-friendly nature. Following materials were used in removal of iron from water discussed below.

4.6.1 Reagents

The chemicals used were Sodium hydroxide (NaOH), Hydrochloric acid (HCl), Calcium Chloride CaCl_2 . Sodium Hydroxide (NaOH) and P_H buffer solutions were used to adjust PH value of samples. The glasswares was rinsed with dil.HNO_3 . water samples were collected around Perumbakkam. Doubly distilled water is obtained from our lab.

4.6.2 Preparation of Banana peel powder adsorbent

Fresh banana peels were collected from domestic wastes, as its availability and transportation was easy. Banana peel contains lipids (1.7%), proteins (0.9%), crude fiber (31%) and carbohydrates (59%). The various minerals present are potassium (78.10 mg/g), manganese (76.20 mg/g), sodium (24.30 mg/g), calcium (19.20 mg/g) and iron (0.61 mg/g). The peels were washed several times with tap water and followed by distilled water. Dried banana peels crushed in a jaw crusher and then sieved. Screened material is treated with 0.1 M hydrochloric acid for 24 h. After treatment with acid, treated material is washed many times to make it neutral. The washed material then cut in to small pieces and allowed to dry in a hot air oven at 80°C for 24 hours. The moisture content was lost from it, the color change was observed from yellow to brownish black. The material is subsequently placed in an airtight container for further use. The dried material was finely ground and screened through 100 mesh size, and stored in polythene bottles.



Fig; 4.8: banana peel



Fig: 4.9: banana peel powder

4.6.3 Preparation of Mosambi peel powder adsorbent

Mosambi tree (*Citrus limetta*) is under the category of citrus species of the family Rutaceae. It is the World's largest produced fruit, accounting for 23% of the world's total fruit production. The peels of mosambi have high pectin content which is a good antidote to blood sugar and cholesterol. Moreover, mosambi peel contains many phytochemicals that are effectively used in pharmaceutical industry for drugs or food supplements. Mosambi peel dust was used as biosorbent for removal of Fluoride from contaminated water. The mosambi peels were collected from local market. They were cleaned to remove impurities and cut into pieces. The mosambi peel dust was first washed thoroughly with deionised water. The soluble coloured components of mosambi peel dust were then removed by washing repeatedly with hot deionised water (70 °C). The peel dust was then dried

at 100 C for 48 hrs. They are kept in the desiccators for 30 minutes. The dried peel dust then crushed, passed through a 100-mesh sieve, and stored in polythene bottles.

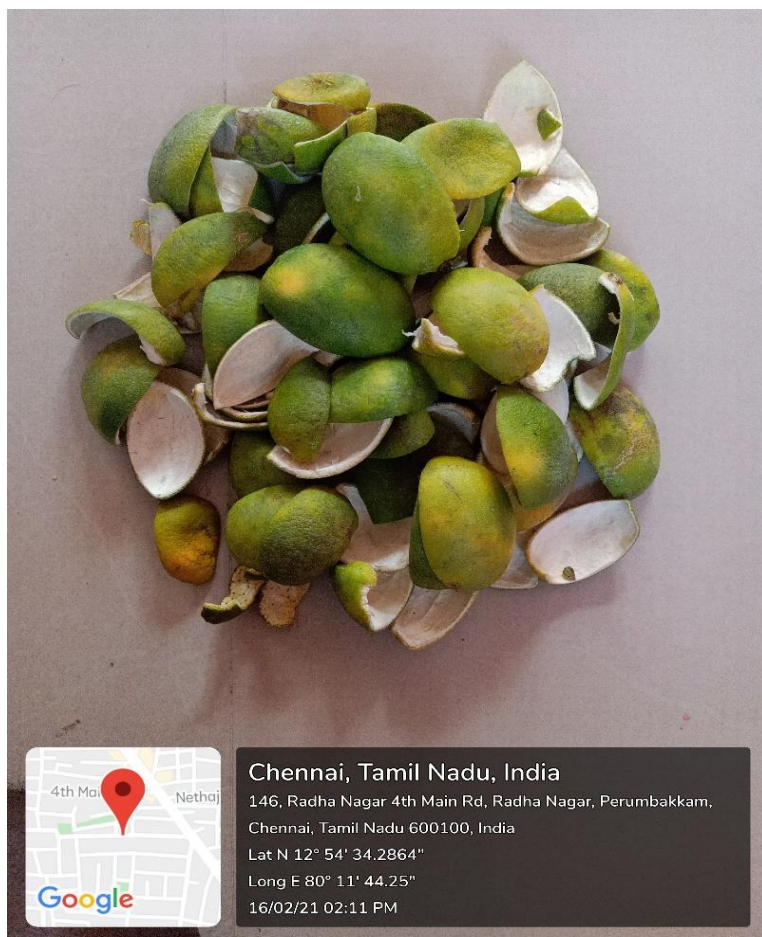


Fig: 4.10: mosambi peel

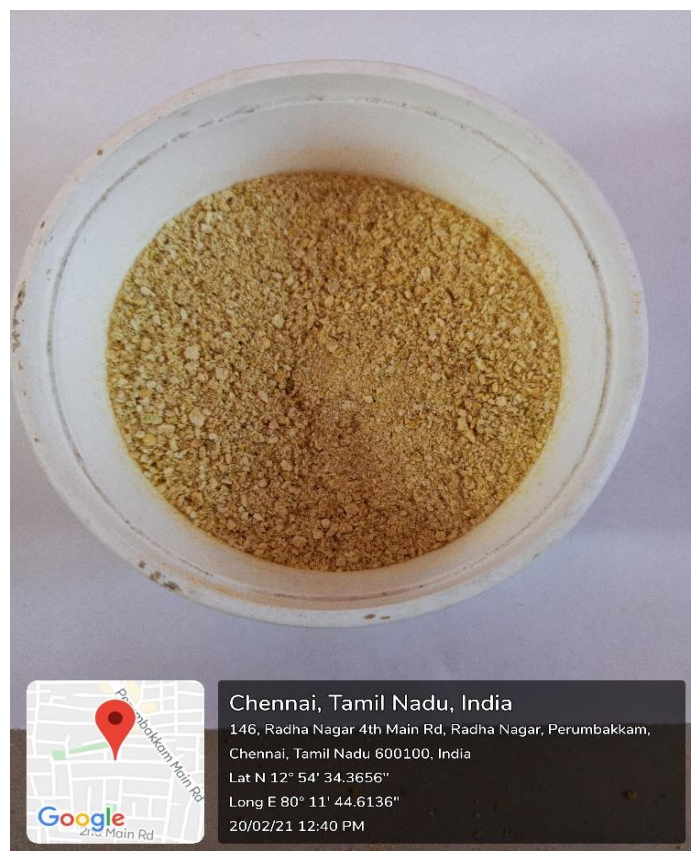


Fig: 4.11: mosambi peel powder

4.6.4 Preparation of Orange peel powder adsorbent

Orange (*Citrus sinensis*, family Rutaceae) contains orange peel (OP) which is an important byproduct. OP comprises cellulose, hemicellulose, lignin, pectin (galacturonic acid), chlorophyll pigments and other low-molecular weight compounds (e.g. limonene). Traditionally, Orange Peel is treated to obtain volatile and nonvolatile fractions of essential oils and flavouring compounds. In addition, OP has been reported to have germicidal, antioxidant, and anticarcinogenic properties, and thus may be effective against breast and colon cancers, skin inflammation, muscle pain, stomach upset and ringworm. The collected peels were cut into small pieces, washed with distilled water to remove dirt and suspended impurities and then dried for 48 hours in an oven at 100°C to remove the moisture content from the peels. After the drying process, the peels were removed from the

oven and kept in the desiccators for 30 minutes. The desiccators contains calcium chloride (CaCl_2) which is used to cool and maintain a dry environment and then the peels are ground to fine powder and sieve through 100 mesh size for particle size. These dehydrated peels were directly used as biosorbents in the experimental investigations.



Fig: 4.12.orange peel

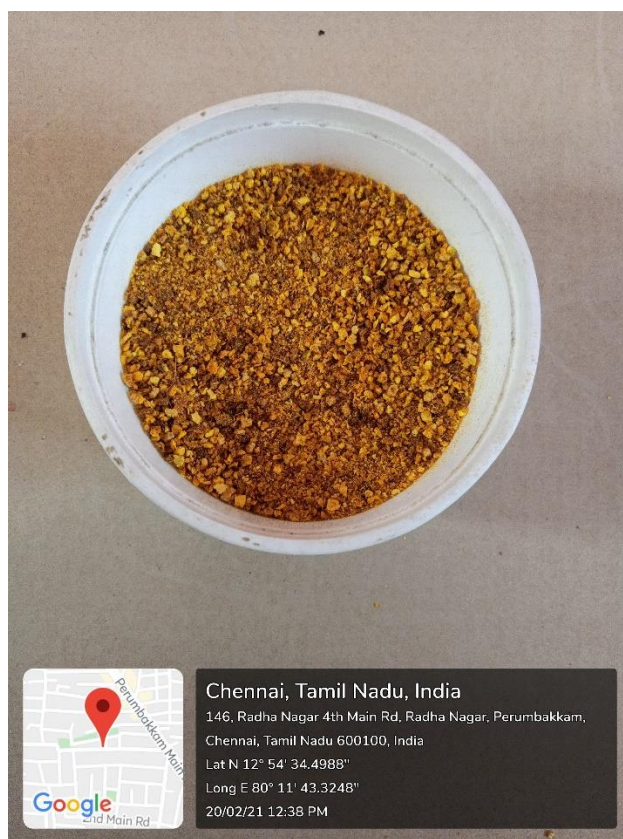


Fig: 4.13: orange peel powder

4.6.5 Plain sand

Fine sand is naturally occurring glacial deposits high in silica content and low in soluble calcium, magnesium and iron compounds are very useful in sedimentation removal. But here the media is used for iron removal from drinking water. Here for the Experimentation plain sand passing through 600 Micron IS sieve were used after washing it thoroughly with tap water followed by doubly distilled water (DDW). Sand being the cheapest adsorbing surface is very effective in removal of dissolved iron from drinking water and the rate of filtration is also very high. The only demerit is subsequent development of bacterial layer due to rigorous use. Again back washing is needed time to time.



Fig: 4.14: Sand used for filtration



Fig: 4.15: Washing of sand

4.6.6 Gravel chips

Gravel filters were found to be very effective for the removal of sediment and heavy metals under all water level regimes even as the system clogged over time. Despite the sediment particle size distribution being much smaller than the filter media pore size, sediment and its time associated pollutants were effectively trapped in the top of the gravel filter.

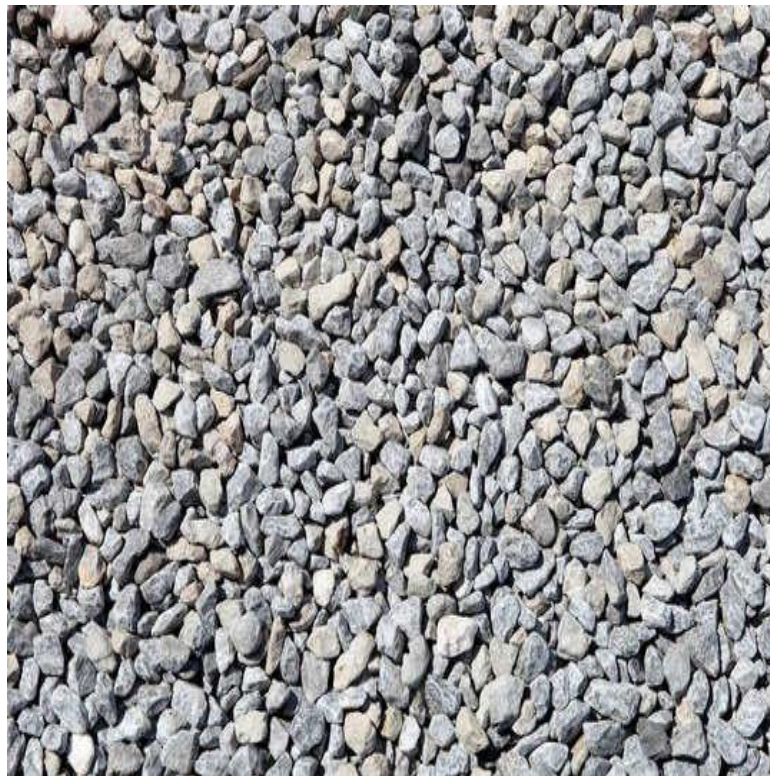


Fig: 4.16: Gravel chips

4.7 FILTRATION MODEL DEVELOPMENT

Here we have manufactured a simple cylindrical filtration bottle as shown in Figure with the following dimensions



Fig: 4.17: Filtration model

4.7.1 Adsorbents cylinder

The cylinder of the mentioned dimensions is used, which is plastic in material and consisted of gravels 7.5cm, plain sand 7.5cm and the adsorbent of particular weight is kept in the cylindrical jar respectively where every layer is covered with a net filter cloth or Whattman paper, when the raw water sample passes through the adsorbent cylinder it purifies the impure water or the raw water with heavy metals like iron and is collected in the water collecting cylinder of the below mentioned dimensions.

- Length = 30 cm
- Diameter = 7.5cm



Fig: 4.18: Filtration mixture in Cylinder

4.7.2 Water collecting cylinder

Water which has filtered through the adsorbent media that has shown in the above Fig: 4.10 and is collected in the water collecting cylinder which has the following dimensions

- Length = 25 cm
- Diameter = 15 cm

A tap was connected to the bottom cylinder which collects the filtered water that has filtered through the adsorbents media which is kept in the above the collecting cylinder.

A supporting container was kept in addition to this cylinder for supporting the lengthy adsorbent cylinder with the help of pebbles. In this adsorbent cylinder a layer of gravel chips, sand, filter paper and the adsorbents wrapped in a filter cover was placed respectively. A filter paper was kept at the bottom of the adsorbent media which was connected with the bottom cylinder to filter the

dissolved solids and filter the water. In the proposed design of the model, the prefabricated water of known iron concentration was passed through the inlet at the top. Inside the bottle cylinder, different adsorption media of specified thickness were placed with proper gravel support. Then after filtration, the filtered water was collected through the outlet part in a beaker as shown in the Figure below.

The final concentration was measured in the Atomic Absorption Spectrometer (AAS). The rate of filtration was noted and for each adsorption media, three samples were tested for each adsorbent and average concentration was considered for analyzing filter effectiveness.



Fig: 4.19: Cylinder to collect water

4.8 FILTRATION PROCESS

For removal of fluoride, the natural materials had been used in the experiments like Banana peel powder, Mosambi peel powder and orange peel powder. The following adsorption media had been experimented here for removal of fluoride from collected raw water sample.

4.8.1 Banana peel powder

The pre-treated banana peel powder, 600 micron sand and gravel chips are taken for filtration process where top layer is of pre-treated banana peel powder of the amount of 50,100and 150 grams is taken in a filter cover followed by sand and gravel chips at the bottom. Known concentration of raw water sample was passed through the pre-treated banana peel powder and filtrate was collected in a beaker then it is filtered through a Whatman filter paper. The rate of filtration was calculated and final fluoride concentration was measured.



Fig: 4.20: Banana peel powder in filter media



Fig: 4.21: Pouring of raw water for filtration



Fig: 4.22. Collecting filtered water

4.8.2 Mosambi peel powder

The pre-treated Sugarcane bagasse, 600 micron sand and gravel chips are taken for filtration process where top layer is of pre-treated mosambi peel powder of the amount of 50,100 and 150 grams is taken in a filter cover followed by sand and gravel chips at the bottom. Known concentration of raw water sample was passed through the pre-treated mosambi peel powder and filtrate was collected in

a beaker then it is filtered through a Whatman filter paper. The rate of filtration was calculated and final fluoride concentration was measured.



Fig :4.23.mosambi peel powder in filter media



Fig: 4.24: Sample poured into filtration chamber



Fig: 4.25. Collecting filtered water

4.8.3 Orange peel powder

The pre-treated powdered orange peel, 600 micron sand and gravel chips are taken for filtration process where top layer is of pre-treated orange peel powder of amount of 50,100 and 150 grams is taken in a filter cover followed by sand and gravel chips at the bottom. Known concentration of raw water sample was passed through the pre-treated orange peel powder and filtrate was collected in a beaker then it is filtered through a Whatman filter paper. The rate of filtration was calculated and final fluoride Concentration was measured.



Fig :4.26.orange peel powder in filter media



Fig: 4.27: Pouring of raw water for filtration



Fig : 4.28. Collecting filtered water

CHAPTER 5

RESULTS AND DISCUSSION

5.1. Banana peel powder

The results are obtained in removal of fluoride by using banana peel powder as mentioned in 4.1. The effectiveness in removing fluoride are tabled here. The initial concentration of fluoride in the sample is 1.3mg/l respectively and the results are shown in the following Table.

Table 5.1 Results of filtration using Banana peel powder

Sample no	Amount of banana peel powder in grams	Initial concentration in mg/l	Final concentration in mg/l
1.	50	1.3	0.9
2.	100	1.3	0.75
3.	150	1.3	0.51

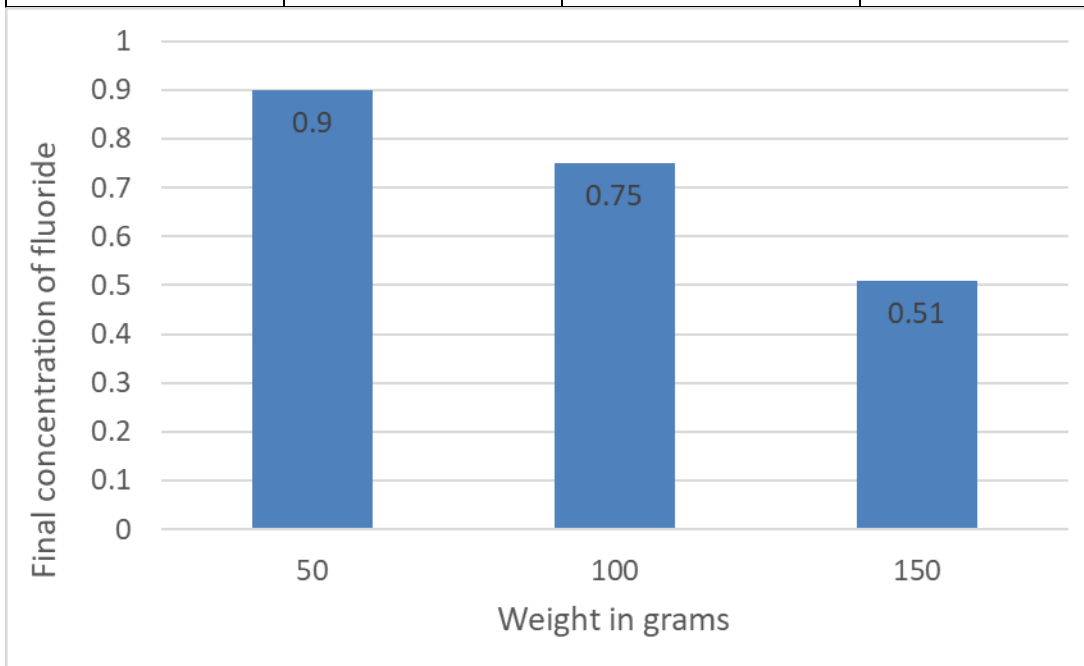


Fig:5.1: fluoride removal in banana peel powder

5.2. Mosambi peel powder

The results are obtained in removal of fluoride by using Mosambi peel powder as mentioned in 4.1. The effectiveness in removing fluoride are tabled here. The initial concentration of fluoride in the samples is 1.3mg/l and the results are shown in the following Table.

Table 5.2 Results of filtration using mosambi peel powder

Sample no	Amount of mosambi peel powder in grams	Initial concentration in mg/l	Final concentration in mg/l
1.	50	1.3	0.8
2.	100	1.3	0.65
3.	150	1.3	0.4

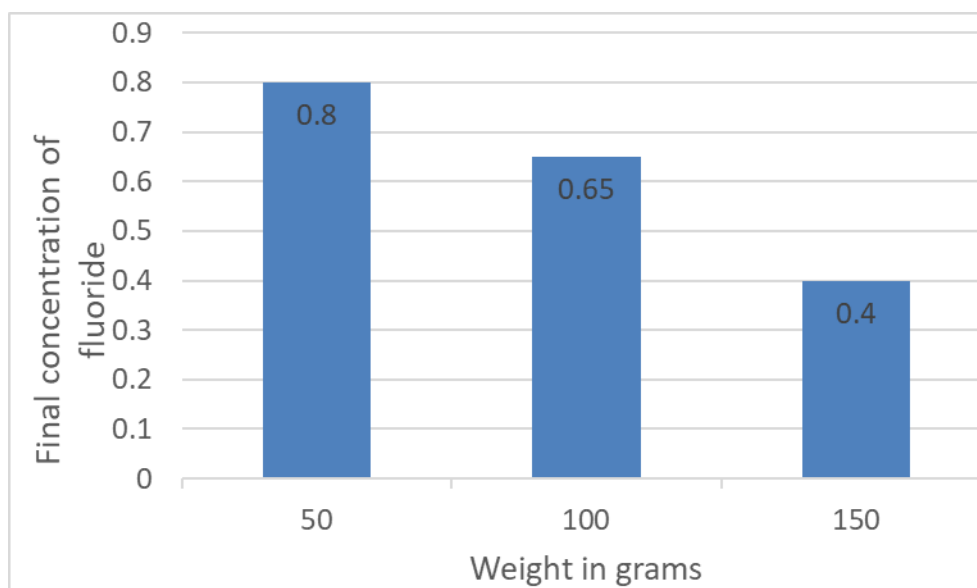


Fig:5.3: fluoride removal in mosambi peel powder

5.3. Orange peel powder

The results are obtained in removal of fluoride by using Orange peel powder as mentioned in 4.1. The effectiveness in removing fluoride are tabled here. The initial iron concentration of fluoride in the samples is 1.3mg/l and the results are shown in the following Table.

Table 5.3 Results of filtration using Orange peel powder

Sample no	Amount of orange peel powder in grams	Initial concentration in mg/l	Final concentration in mg/l
1.	50	1.3	1.0
2.	100	1.3	0.72
3.	150	1.3	0.64

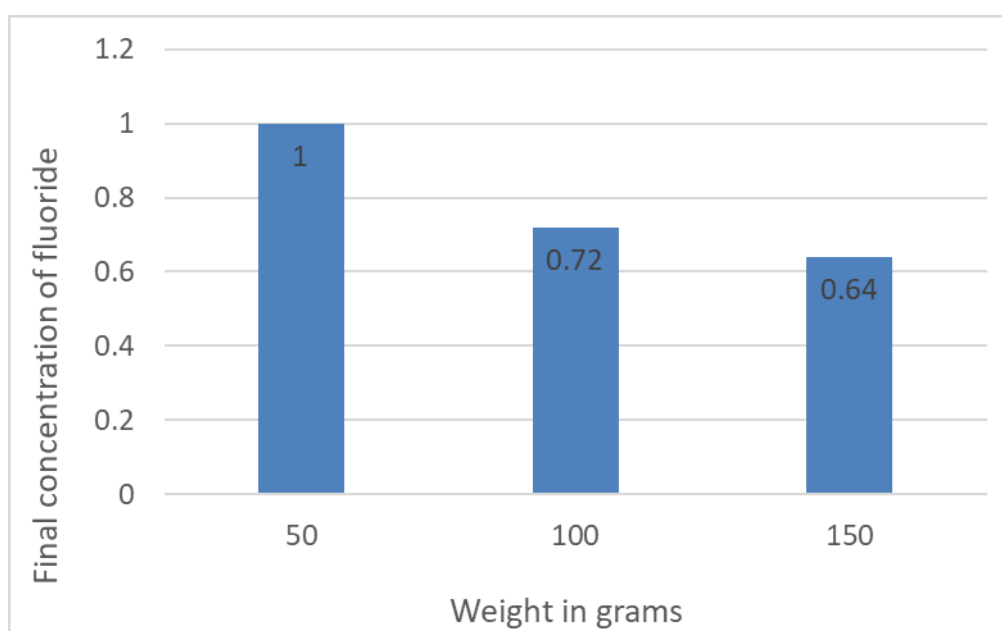


Fig: 5.3: fluoride removal in orange peel powder

Comparison of result

1. In mosambi peel powder better result obtained in sample 3 which removed fluoride concentration Was 90%
2. In banana peel powder better result obtained in sample 3 which removed fluoride concentration Was 79%
3. In orange peel powder better result obtained in sample 3 which removed fluoride concentrartion Was 66%

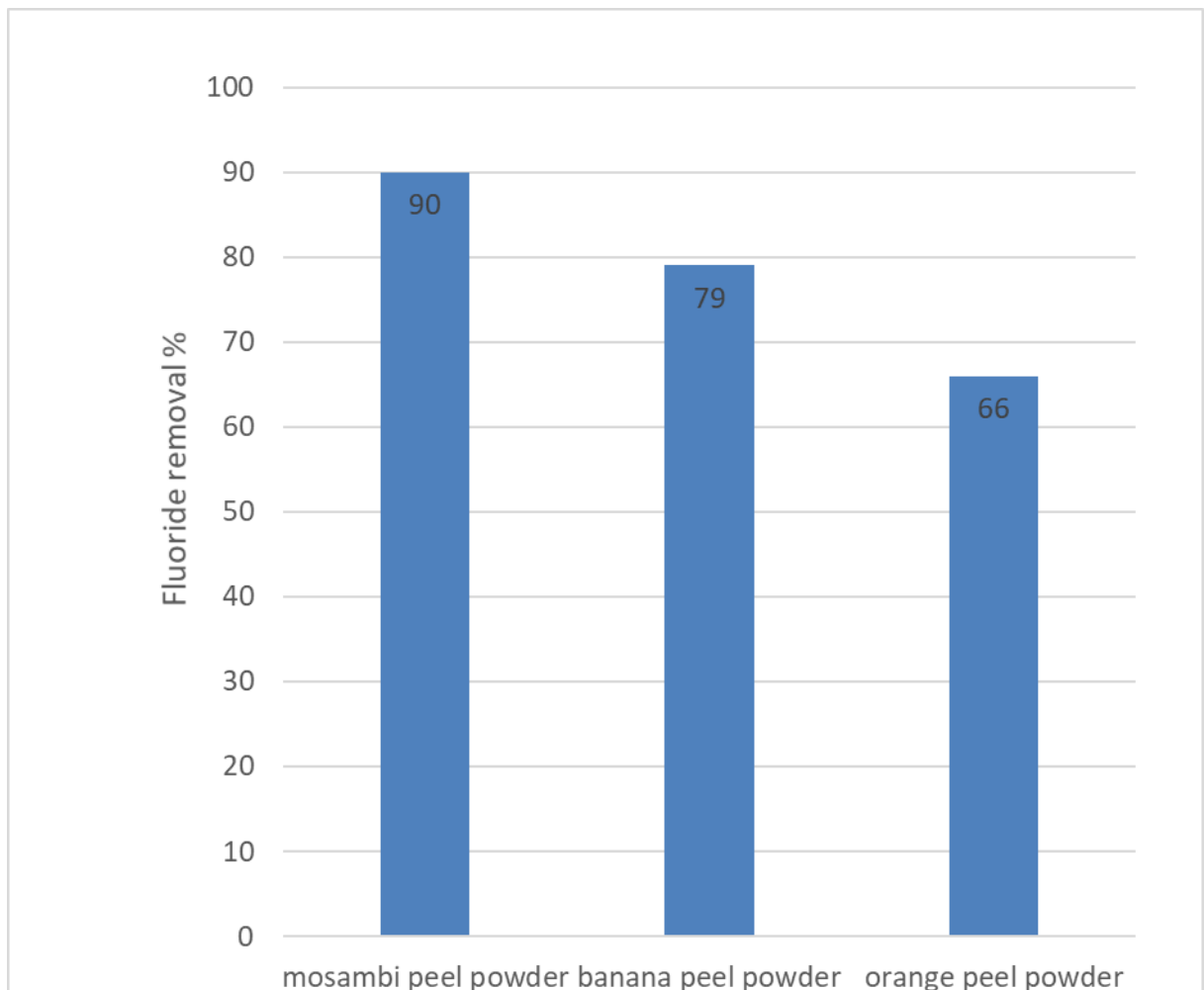


Fig: 5.4: variation of % of fluoride removal using banana peel powder, mosambi peel powder and orange peel powder

5.4 COST OF THE FILTER

A chart had been provided for the cost of all the adsorbent media used for experimentation the material cost of each adsorption media per kg used for experimentation is given in the table and the total cost as per the amount of material used is also mentioned in the table.

Table 5.4: Material cost of different adsorbent media used in experimentation

Material	Amount of material used for experimentation in kg	Rate of material per kg in rupees	Total cost in rupees
Banana peel powder	0.3	25	7.5
Orange peel powder	0.3	-	-
Mosambi peel powder	0.9	15	13.5
Sand	0.003	200	6
Cylindrical bottles	-	-	150

CHAPTER 6

SUMMARY AND CONCLUSION

- Adsorption being the simplest and cheapest technique for fluoride removal, it has several advantages, like longer filtration runs, shorter ripening time, better filtrate quality. But the only limitation is back wash water requirement is essential for the filter media to run effectively.
- Sand being the cheapest adsorbing surface is very effective in removal of dissolved iron from drinking water and the rate of filtration is also very high. The only demerit is subsequent development of bacterial layer due to rigorous use, Again back washing is needed time to time.
- Biosorption of fluoride in samples by Orange peel powder is insignificant with lesser absorption rate.
- Banana peel powder removed good amount of fluoride from sample solution with adequate efficiency.
- Mosambi peel powder possess excellent removal efficiency of fluoride from samples. This may be due to larger particle size of material being used. Smaller the size of particle larger will be the specific surface and better will be the removal. Mosambi peel has highest removal efficiency, which is followed by Banana peel powder and Orange peel powder.
- High surface area of Mosambi peel powder, adds to the property and makes it an excellent and economic adsorbent than Banana and orange peel powders, for water purification process. Thus the use of mosambi peel as a low cost biosorbent for the fluoride removal was proved to be economic feasible in the treatment of industrial waste water.
- The bio-adsorbents once used could be re-used through desorption methods for a certain period of time and this could be employed commercially in the future.

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