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DEVELOPMENT OF LOW COST BIO-FILTER USING HERBAL TECHNIQUE

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ABSTRACT

It is well known fact that clean water is absolutely essential for healthy living. Adequate supply of fresh and clean drinking water is a basic need for all human beings on the earth, yet it has been observed that millions of people world wise are deprived of this. Contaminated water plays significant role in taking numerous lives in these localities, for which a number of efforts are being made for accessing safe purified drinking water. Fortunately, efficient and cheap water purification systems are being utilized and being tried to be accessed worldwide for easy access to clean water.

In the following project we had tried to develop a "Low Cost Water Purification Technique "using the basic ideas of bottle filter, some locally Herbal available filter material like Tulsi leaves powder, Neem leaves powder, Rice Husk, Sugarcane bagasse, fine graded sand and tries to improve the methodology using the UV Filter, RO Filter, and Activated Carbon Filter mechanism. Main focus was removal of iron from surface water by adsorption technique. Among all the herbal material used, the ash produce from rice husk was proved to give the best result in removal ofthe cheapest material cost. Locally collected Sugarcane cane bagasse and neem leaves powder mixed with calcium hydroxide (chuna) was prepared which also proved to be effective for removal of iron. removal of iron broadly four herbal materials had been used in the experiments i.e. Tulsi leaves powder, neem leaves powder, rice husk and sugarcane bagasse has been adopted. The following adsorption media had been experimented here for removal of iron from drinking water.

Keyword:-*Herbal, removal of iron, cheapest material, adsorption technique.*

1. INTRODUCTION

According world health organization 1.1 billion people lake access to an improved drinking water supply, 88 % of the 4 billion cases of diarrhea disease are attributed to unsafe drinking water and 1.8 billion people die from diarrhea diseases each year (WHO, 2007). Statistics shows that these diseases resulted in ninety per cent of all deaths of children under five years old in developing countries, due to low immunization of children to infections. Reducing death from water borne diseases is a major goal of public health in developing country. Despite of fulfillment of requirement of drinking water standards, the municipal water in used in developing countries is being improved and cost efficient water filtration techniques are being developed commonly used to improve taste or to eliminate any undesired matters.

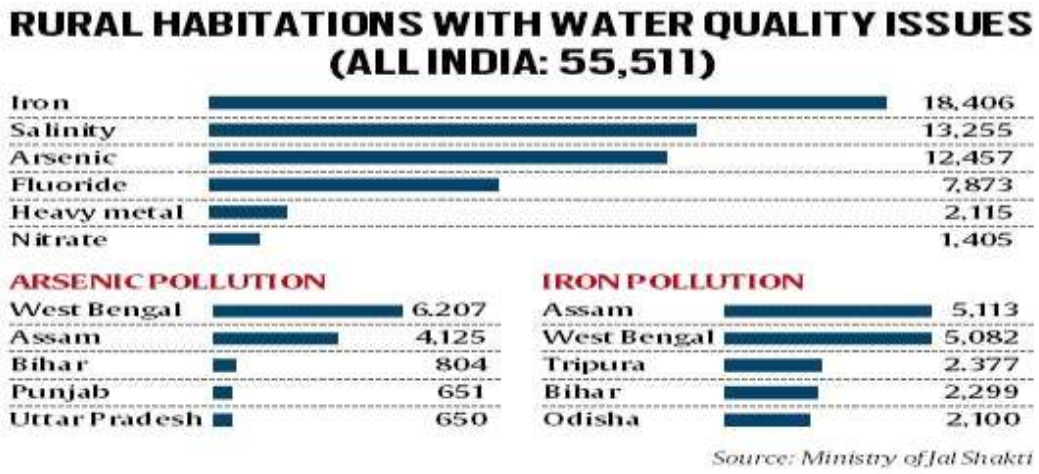
Among rural habitations in Indian states, 55,511 face quality issues with drinking water. As of November 27 this year, 3.22 per cent of rural habitations across all states and UTs, accounting for 3.73 per cent of the population, were consuming drinking water with quality issues, according to data tabled by the Ministry of Jal Shakti in Parliament.

Iron is the most common contaminant of drinking water, with over 18,000 rural habitations affected, followed by salinity that affects roughly 13,000 rural habitations, arsenic (12,000), fluoride (nearly 8,000) and heavy metal.

Rajasthan has the highest number of rural habitations affected by contamination overall, at 16,833. Most of these – 12,182 – are affected by salinity in drinking water, at 12,182.

The scope of this project is to study the existing water filtration methods, and use the knowledge to design a **Low cost water filtration using herbal technique**. This water filtration system made by bottle, which will focus on cutting down the cost while maintaining filter effectiveness, by providing affordable water filters for the rural and remote areas, will greatly improve people's quality of living, and reduce the risk of any waterborne diseases therefore saving lives.

- Critical analysis of various herbal techniques used for identification of water purification.
- Most suitable method for removal of toxic element.
- Development of low cost water purification equipment using different herbal (Tulsi leaves, Neem leaves, Rice husk, sugarcane bagasse, etc.).
- Comparison of Result.



2. MATERAILS AND METHODS

In the proposed design of the model, the prefabricated water of known iron concentration was passed through the inlet pipe above. 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 and the final concentration was measured in the Atomic Absorption Spectrometer (AAS).The rate of filtration was noted and for each adsorption media, three or four samples were tested and average concentration was considered for analyzing filter effectiveness.

Materials used and Preparation of Adsorption Media:

Large number of scientist and environmentalist has investigated the possibility and efficiency of utilization of the herbal as an adsorbent for heavy metal adsorption in polluted water. Following materials were used in removal of iron from water, discussed below.

- **Plane Sand:**

Fine sand and gravel are 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 plane sand passing through 600 Micron IS sieve were used.

- **Tulsi Leaves Powder:**

The scientific name of Tulsi is Ocimum Tenuiflorum, Holy basil or Ocimum Sanctum Linn. Leaves are dropped in drinking water for purification and for medication. In all Hindu temples, water mixed with Tulsi leaves are offered

to devotees every day since the herbal plant is an excellent medicinal plant found all over India and is considered sacred. The leaves, seeds and root of this plant have been used in ayurvedic medicine. Chemical composition is highly complex, containing many nutrients and other biological active compounds. It can remove fluoride levels in drinking water. Recently it's used have been found in fighting fluorosis. They are mainly two types of Tulsi. First is Shyam Tulsi having dark colored stems and leaves and second Rama Tulsi have whitish stem and green leaves.

Here Tulsi leaves powder was used for removal of iron from water. Tulsi leaf powder was purchased from the local market of Gorakhpur.

Fig 3.2 Tulsi leaves powder

Neem Leaves Powder:-

The scientific name of neem is Azadirachta indica. Neem leaf powder was purchased from the local markets of Rourkela. Neem leaves powder was taken for removal of toxic element from water. Here, two methods were adopted. First method was only neem powder used but second method was mixed thoroughly with calcium hydroxide (chuna) 1:10 ratio.

Fig 3.3 Neem leaf powder

Chemical formula of calcium hydroxide is Ca(OH)2. It is springily soluble in water and forms a solution called lime water.

Rice husk:

Rice husk are the hard protecting covering of grains of rice. Around 20% of the paddy weight is Husk. Scientific name for rice is oryza sativa. The chemical composition of Rise husk is similar to that of many common organic fibres and it contains of cellulose 40-50%, lignin 25- 30%, ash 15-20% and moisture 8-15 %(by Hwang and Chandra 1997). After burning, most evaporable components are slowly lost and the silicates are left. Low value agricultural by rice husk can be made purification of water. Rice husk was collected from a local mill in jehanabad, Bihar. The rice husk was sieved in the mesh in the range of 600 micron in order to increase its surface area. This was used as and adsorbent along with sand as a base material.

Fig 3.4 Rice Husk

Aluminum hydroxide coated Rise husk Ash:

Rice husk ash (RHA) is generated by burning rice husk. Cellulose and lignin are removed by burning and leaving behind silica ash. Rice hush ash was produced by controlled temperature and environment of burning process in muffle furnace at a temperature of 500 degree Celsius for 3 hours. The RHA was first soaked with 0.01 N HCl. Dry RHA of 100 gm, 0.6 M of aluminum salt (Aluminum Sulphate salt) solution and 3M sodium hydroxide was added and stirred for one hour and then the filtered rice husk ash was kept in oven for 3 hours at 373 K [12, 13].This was used as an adsorbent along with sand as a base material.

Fig. RHA coated with Al (OH) $_3$ **Fig. Rice Husk Ash**

Fig 3.5(c) Muffle furnace

From, fig 3.5 (c) Muffle furnace is a device used for heating and converts sample to ash. It is oven type equipment. Muffle furnace are most often utilized in laboratories as a compact means of creating extremely high temperature atmosphere. They have coarse and fine turn. Coarse turn used for large interval temperature but fine turn to hold very accurate and stable temperature with very little variance. They are used to test the characteristics of materials at these extremely high and accurate temperatures.

Sugarcane Bagasse:

Bagasse is sugarcane fiber waste left after juice extraction. Bagasse contains mainly cellulose, hemi cellulose, pentosans, lignin, sugars, wax and minerals. Sugarcane bagasse was collected from Makhdumpur in Jehanabad,

Bihar. It was first washed thoroughly with tap water and again washed with distilled water to remove dirt and metallic impurities and after which it was dried in the oven at about 105 degree Celsius for 3 hours and 24 hours dried in sun light. The dried bagasse was grounded and made like fine particles to increase its surface area and 0.1M HCL was added in 100gram bagasse. This was used as an adsorbent along with sand as a base material.

Fig 3.6 Sugarcane bagassee

METHOD

In the proposed design of the model, the prefabricated water of known iron concentration was passed through the inlet pipe above. 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 and the final concentration was measured in the Atomic Absorption Spectrometer (AAS).The rate of filtration was noted and for each adsorption media, three or four samples were tested and average concentration was considered for analyzing filter effectiveness.

Procedure

1-Plant Material- Matue leaves of neem and tulsi were collected from the near by area

-Sugarcane bagasse was collected from the vendors selling sugarcane juice.

-Rice husk is collected from the local village and burnt in a way that it do not get turn complete to ash,only burnt from top surface.

Other Material-Sand is collected from near by area.

-Sponge and nylon cloth are available at home.

2)-All the materials were segregated and washed with tap water followed by distilled water(If available),seived and dried before use.

3)-The container in which all the materials are to be kept should be cleaned and dried properly.

4)-Since all the materials are disinfected and dried, all the materials are layered one by one.

5)-Starting from botton,Nylon cloth-Sponge-Sand-RHA-Sand-Sugarcane Bagasse-Neem leaf-Tulsi leaf-Sponge.

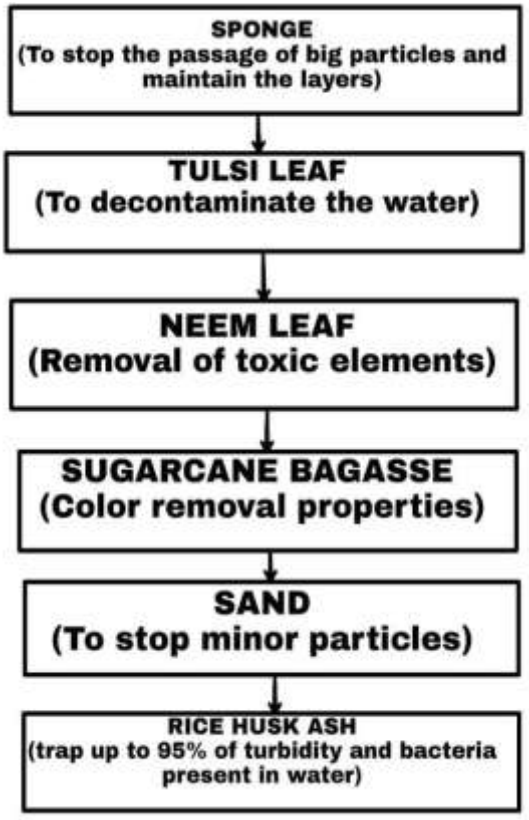
6)-After placing the material in layered form, pour the clean water for several times till the clean water comes.

7)-Collection of Water Sample-River water is collected from Rapti River, Gorakhpur.

Pond water is collected from Ramgarhtal, Gorakhpur.

The samples were stored in pre cleaned, autoclaved plastic cans and immediately used for experiment.

8)-Treated water samples is to be gone through different test to check its quality i.e., weather it is fit for drinking or not.



4. RESULTS AND DISCUSSION

Tulsi leaves powder:

The results are obtained in removal of iron by using Tulsi powder as mentioned in 4.1. The rate of filtration and the effectiveness in removing iron are tabled here. The initial iron concentration was 1.053ppm and better removal iron (in %) in sample 1 but rate of filtration in this case was lesser. The results are shown in Table 5.1 and Figure 5.1.

Table 5.1 Results of filtration in Tulsi leaves powder

Sample No	Thickness of Sand Layer (in cm)	Amount of Tulsi Leaf powder (gram)	Initial iron content (ppm)	Final iron content (ppm)	Rate of filtration (ml/min)
1.	Top layer=2cm Bottom=3cm	50gram	1.053	0.974	185
2.	Top layer and bottom+2cm	40gram	1.053	0.998	238
3.	Top layer and bottom =3 cm	40gram	1.053	0.983	192

Fig 5.1 Iron removal in Tulsi leaves

Neem leaf powder:

The results are obtained in removal of iron by using Neem powder as mentioned in 4.2.1. The rate of filtration and the effectiveness in removing iron are tabled here. The initial iron concentration was 1.317ppm and better removal iron (%) obtained in sample 3 but rate of filtration in this case was lesser. Neem leaf powder has given the better result compared to the Tulsi leaf powder. The results are shown in Table 5.2.1 and Figure 5.2.1.

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Table 5.2.1 Results of filtration in Neem leaves powder

Sample no:	Thickness of sand layer (cm)	Amount of Tulsi Leaf powder	Initial iron content (ppm)	Final iron content (ppm)	Rate of filtration (ml/min)
1.	Top layer=2cm Bottom=3cm	50gram	1.317	0.710	200
2.	Top layer and Bottom=2cm	40gram	1.317	0.890	227
3.	Top layer and bottom=3cm	40gram	1.317	0.698	208

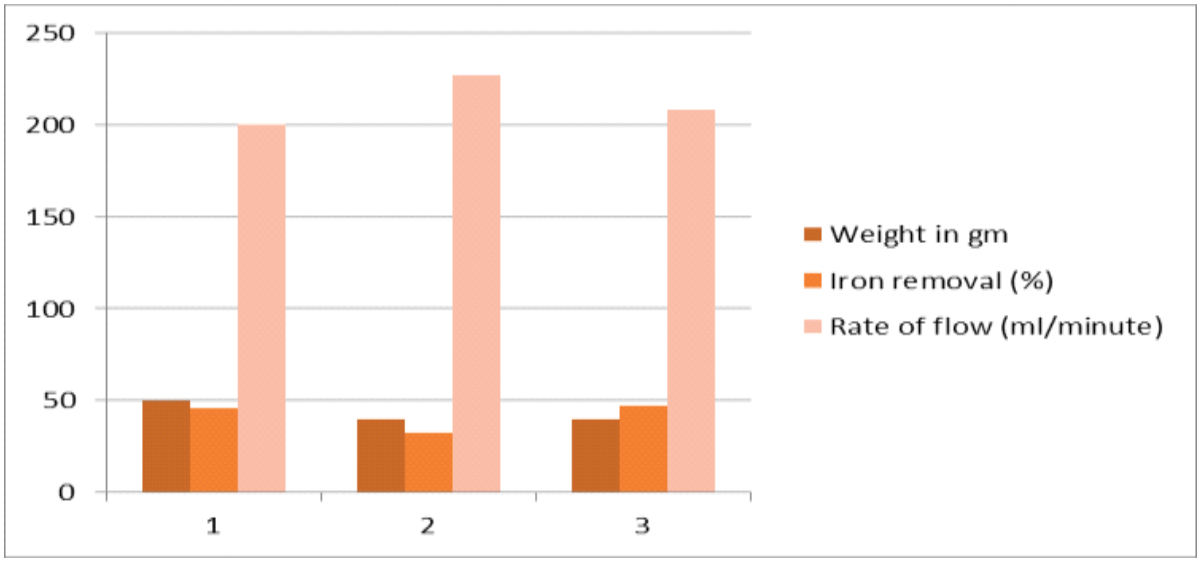

Fig 5.2.1 Iron removal in Neem leaves powder

The results are obtained in removal of iron by using Neem leaf powder mixed with chuna (Ca (OH) 2) as mentioned in 4.2.2. The rate of filtration and the effectiveness in removing iron are tabled here. The initial iron concentration

was 1.317ppm and better removal iron % in sample 1 but rate of filtration in case was lesser. It gives better result compare to the Neem leaf powder. The results are shown in Table 5.2.2 and Figure 5.2.2.

Table 5.2.2 Results of filtration in Neem leaf powder mixed with chuna

Sample no:	Thickness of sand layer(cm)	Amount of Tulsi Leaf powder	Initial iron content (ppm)	Final iron content (ppm)	Rate of filtration (ml/min)
1.	Bottom layer=2cm	100gram	1.317	0.579	140
2.	Bottom layer=2cm	75gram	1.317	0.632	153
3.	Bottom layer=2cm	50gram	1.317	0.676	167

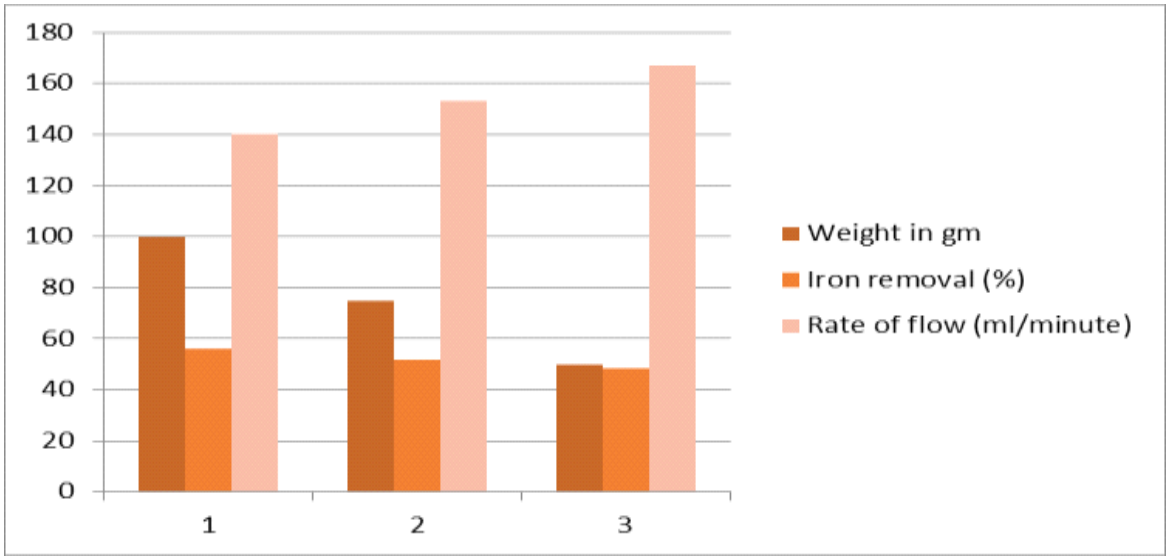

Fig 5.2.2 Iron removal with Chuna mixed Neem powder

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Rice husk:

The results are obtained in removal of iron by using rice husk as mentioned in 4.3. The rate of filtration and the effectiveness in removing iron are tabled here. The initial iron concentration was 2.378ppm and removal from 1.611 ppm by averaging the concentration of three samples. The results are shown in Table 5.3 and Figure 5.3.

Table5.3 Results of filtration in unmodified rice husk

Sample no.	Size of RH (micron)	Initial Iron content (PPM)	Final Iron Content (PPM)	Rate of filtration (ml/min)
1	600	2.378	1.593	160
2	600	2.378	1.569	160
3	600	2.378	1.671	160

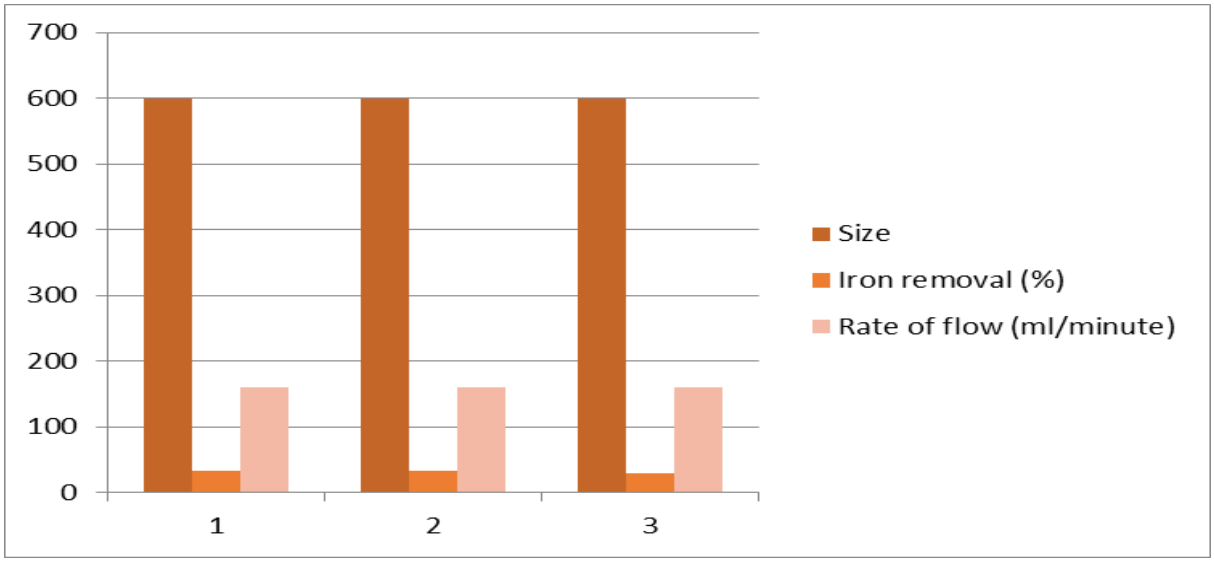

Fig 5.3 Iron removal in Rice husk

Al (OH) 3 coated Rice husk ash:

The results are obtained in removal of iron by using Al (OH) 3 coated Rice husk ash as mentioned in 4.4. The rate of filtration and the effectiveness in removing iron are tabled here. It gave satisfactory result in removal of iron compare to unmodified rice husk. The initial iron concentration was 2.378ppm and removal from 0.562ppm by averaging the concentration of three samples. The results are shown in Table 5.4 and Figure 5.4.

Table5.4 Results of filtration in modified rice husk

Sample No.	Size of RH (micron)	Initial Iron content (PPM)	Final Iron Content (PPM)	Rate of filteration (ml/min)
1	600	2.378	0.469	170
2	600	2.378	0.563	170
3	600	2.378	0.656	170

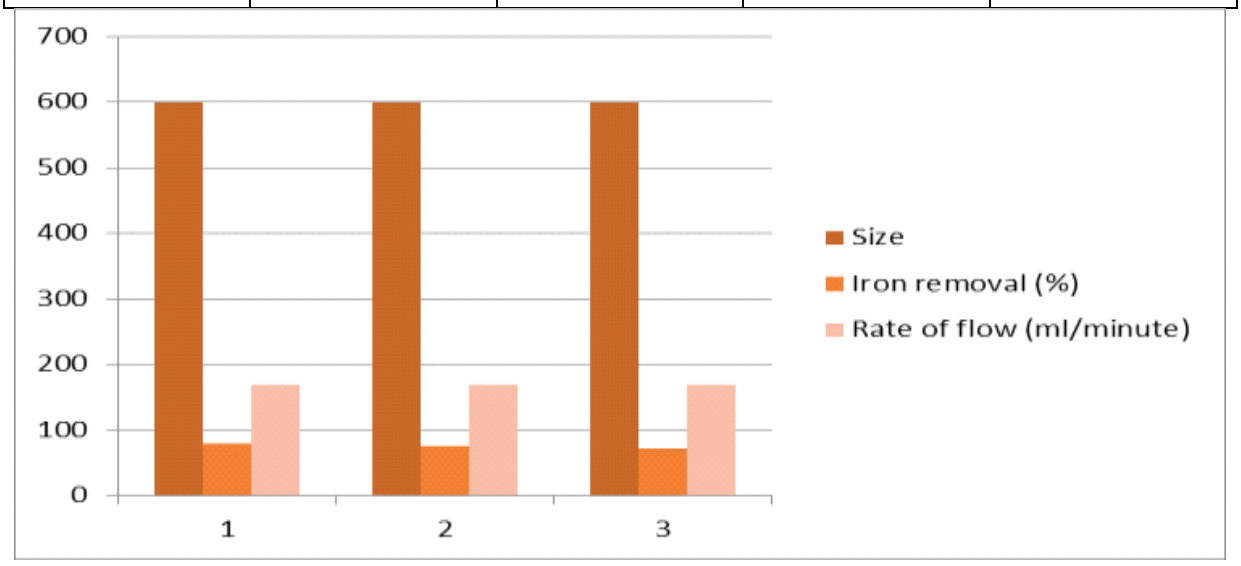

Fig 5.4 Iron removal in $Al(OH)_3$ coated rice husk

Sugarcane bagasse (SB):

The results are obtained in removal of iron by using Sugarcane bagasse (SB) as mentioned in 4.5. The rate of filtration and the effectiveness in removing iron are tabled here. The initial iron concentration was 2.378ppm and removal from 1.394ppm by averaging the concentration of three samples. The results are shown in Table 5.5 and Figure 5.5.

Table5.5 Results of filtration in Sugarcane bagasse

Sample no	Amount of SB (gram)	Initial Iron content (PPM)	Final Iron Content (PPM)	Rate of filtration (ml/min)
1.	100	2.378	1.396	220
2.	100	2.378	1.589	220
3.	100	2.378	1.297	220

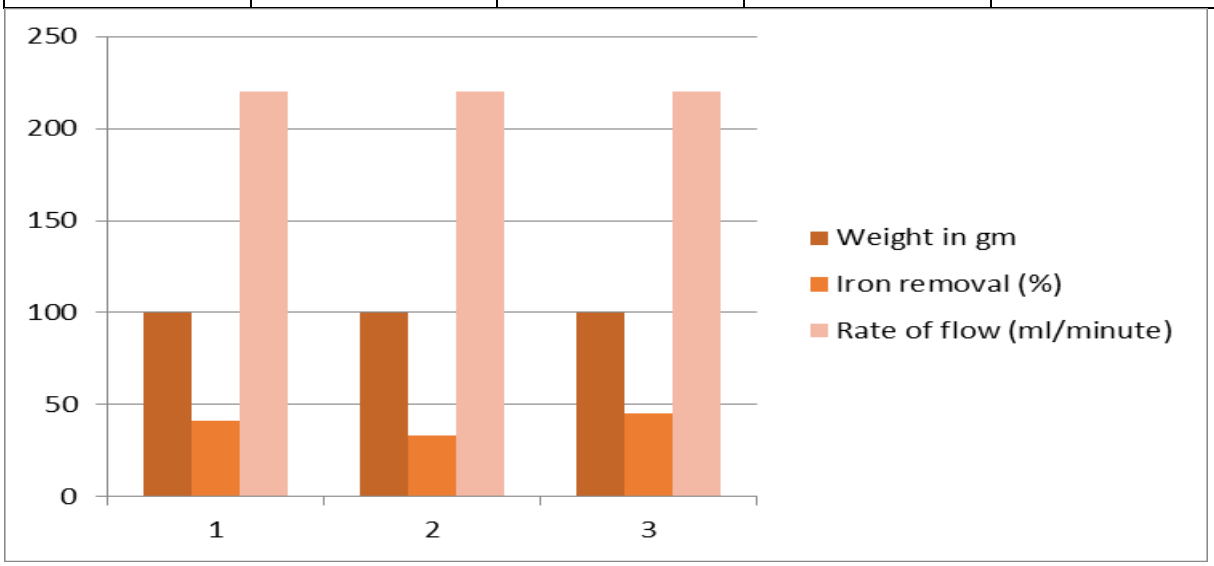

Fig 5.5 Iron removal in Sugarcane Bagasse

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Comparison of result:

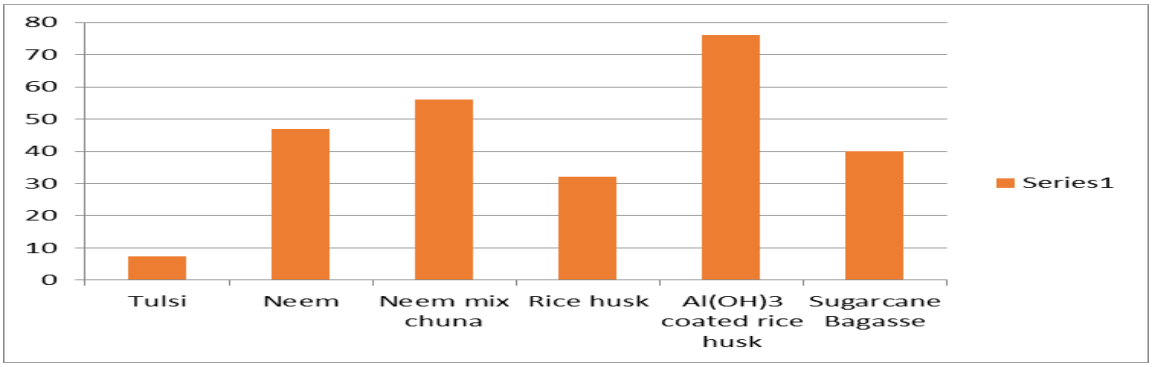

Fig5.6 Variation of % removal of irons with different herbal used

Figure 5.6. in x-axis indicated:

- In Tulsi leaves powder, better result obtained in sample1 which removed the ironconcentration was 7.502%.
- In Neem leaves powder, better result obtained in sample3 which removed the iron concentration was 47.00%.
- In Neem leaf powder mixed with chuna, better result obtained in sample1 which remove the iron concentration was 56%.
- In unmodified rice husk remove the iron concentration was 32%.
- Modified (Al (OH) 3 coated) Rice husk was 76 %.
- Sugarcane bagasse remove the iron concentration was 40% by averaging the concentration of three samples.

Cost of the filter

Here we have provided a chart for the cost of all the adsorbent media we have used for experimentation excluding the labour cost, maintenance cost and energy cost. Here 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.

Table 5.6 Material cost of different adsorbent media used in experimentation

Material	Amount used for experiment (kg)	Rate per kg In rupees	Total cost In rupees
Sand	0.9	15	13.5
Tulsi leaf powder	0.2	300	60
Neem leaf powder	0.3	150	45
Rice husk	0.6	20	12
Aluminum sulphate	0.05	20	1
Sugarcane bagasse	0.2	20	4
Bottle	---	- --	2

CONCLUSIONS

- Adsorption being the simplest and cheapest technique for iron 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.
- Tulsi leaves powder is not improve to be a good adsorbent in removal of iron.
- Neem leaf powder mixed with chuna (Ca (OH) 2) proved to be good result in removal of iron compare to untreated Neem leaves powder. Because modified Neem powder decreased the rate of filtration.
- Aluminum hydroxide coated RHA also proved to be a good adsorbent in removal of iron. Previously Ganvir, et al. in 2011 has been experimented that it forms complexes with fluoride ion for its removal. Here in case of iron, there is no proof of formation of any complex. So the removal may be credited to roughening of RHA surface due to modification by Auminium hydroxide.

- Sugarcane bagasse, the removal is not so significant. This may be due to lager particle size of material being used. Smaller the size of particle larger will be the specific surface and better will be the removal.

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