DEVELOPMENT OF ECONOMICAL BIO-FILTER USING HERBAL TECHNIQUE

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ABSTRACT

It is well known that purified water is unconditionally indispensable for well living. Passable supply of fresh and clean potable water is a basic necessity for all human beings, yet it has been perceived that millions of people are underprivileged of this. Dirtied water plays noteworthy role in taking frequent lives in under-developed localities, for which a numeral of efforts are being made for retrieving purified drinking water. Providentially, well-organized and inexpensive water purification systems are being employed and being tried to be opened worldwide. In the following work, it has been tried to develop a "Low Cost Water Purification Technique "using the basic ideas of bottle filter, some easily available Herb based filter material like Tulsi leaves powder, Neem leaves powder, Rice Husk, Sugarcane bagasse, fine graded sand and an effort has been made to improve the methodology using the UV Filter, RO Filter, and Activated Carbon Filter mechanism. Main focus has been laid on the removal of iron from surface water by adsorption technique. Among all the herbal material used, the ash produced from rice husk was proven to give the best result in the removal of the impurities. Locally collected Sugarcane cane bagasse and neem leaves powder mixed with calcium hydroxide, also proved to be effective for removal of iron.

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

1. INTRODUCTION

According to World Health Organization, 1.1 billion people easily access improved drinking water supply. As per findings of WHO, (2007), 88 % of the 4 billion cases of diarrhoea are accredited to hazardous consumption of water and 1.8 billion people die from water borne diseases each year. Statistics demonstrates that these diseases ensued in ninety per cent of demises of children below five years old in developing countries, due to truncated immunization to infections.[1] Dropping death from water borne diseases is the foremost goal of public health in developing countries. Regardless of execution of prerequisite of drinking water standards, the municipal water used in developing countries is being improved and tried for cost efficient water filtration procedures to progress taste or to eradicate any undesired matters. [2] Among rustic tenancies in Indian states, 55,511 face superiority issues with drinking water. As of latest findings, 3.22 per cent of rural habitations across throughout India, accounting for 3.73 per cent of the populace, were consuming drinking water with superiority issues, according to data tabled by the Ministry of Jal Shakti in Parliament, as mentioned in Table 1. Iron is the most collective pollutant of drinking water, with over 18,000 countryside habitations exaggerated, and surveyed by salinity that distresses unevenly 13,000 rural habitations, arsenic (12,000), fluoride (nearly 8,000) and heavy metal.[3] In the past, various types of filters have been designed to be more suitable for the rural areas of the countries, but the cost as well as the filter effectiveness is still not satisfactory and further improvement is still required Hazeltine (1999)[4]. Drinking water is being the biggest issue nowadays in India. Most of the people in the rural areas are not able enough to use water filters or buy mineral water bottles. To overcome this problem many efforts have been done due to which cleaning water may become an affordable commodity. Every house hold should be able to develop its own drinking water purification system; this should be the aim of development of any low cost water purification technique. In this context a number of contributions that has been made where the filter media varies from a layer of simple cotton cloth to composite nano materials. Some of the typically used water filtration methods in India have been discussed here.

In some of the rural areas, women use cotton cloth layers for water filtration Ramachandran (2006)[5]. This method is very cheap, cost effective in removal of sediments or any suspended solids, but may be not completely suitable for drinking purpose. Some places people are using simple plastic bottles with open end, inside which a layer of bone char followed by a layer of sand and a layer of pebble on both sides of the bone char layer is being used through which water will be passed for filtration. This kind of filtration process is

capable of removing sediment and microbes effectively from water. Solar distillation and solar sterilization are the recent but convenient technologies developed as a low cost water filtration process LeMar et al (2010)[6]. In this process water filled

clean plastic bottles are left in sun for several hours so that the UV radiation and the heat generated will be able to kill the microbes present in water causing many water borne diseases. Now these methods are improvised by using thermal indicators inside the bottle letting the users know when it will be safe to drink the water. But despite of being cheap and

effective, this method is a function of availability of solar light. So maybe not abundantly used in water purification process. In comparison with solar sterilization, the solar distillation

technique is even capable of purifying muddy water or salty water through the process of evaporation and condensation

Rajasthan has the highest number of rural habitations affected by contamination overall, The present work 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 is 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 quality of living, and reduce the risk of any waterborne diseases.[7]

The following key-points have been taken care of.

• Critical investigation of numerous herbal practices used for identification of water purification.

• Most appropriate technique for exclusion of toxic element.

• Development of low cost water purification equipment using different herbal sources as

Tulsi leaves, Neem leaves, Rice husk, sugarcane bagasse, etc. [8]

Recently Indian institute of technology Madras (IITM) has developed an effective low cost

water filtration model specifically meant for rural areas which uses a cheap plastic mesh

which is capable of removing 98 percent of impurities from water including pathogens

pradeep, et al (2013)[10]. The cost of the filter is somewhat Rs 700 to 800 and very easy for reuse. Another recent development of IIT M is development of composite nano material used as a filter media which capable of removing toxic metal ions as well as killing the pathogens.

The filter is worth rupees Rs 500 excluding the cartridge. Another attractive feature of this filter media is that the cartridge can be reused by simply boiling in water or rubbing with lemon juice which is easily available in common households. India's largest company Tata Group has developed a very cheap water filter known as "Swach", cost of which is less than Rs1000. It uses nano-technology for filtration and silver

particles for eradicating bacterial contamination.

Ultimately the aim of development of any low cost water filtration model should be to

operate with minimum energy, minimum maintenance, cost effective, environment friendly, implementable with ease and can be developed from local artisans. This will subsequently inspire the people to put hygiene in to habit and of course will help in the social and economic growth of the country.

Table 1 Rural Habitations with water quality issues (All India: 55,511)

S. No	Issue	Figures
1.	Iron	18,406
2.	Salinity	13,225
3.	Arsenic	12,457
4.	Fluoride	7,873
5.	Heavy metal	2,115
6.	Nitrate	1,405

Table 2 Arsenic Pollution

S. No	State	Figures
1.	Assam	6,207
2.	West Bengal	4,125
3.	Tripura	804

4.	Bihar	651
5.	Orissa	650

Table 3 Iron Pollution

S. No	State	Figures
1.	West Bengal	5,113
2.	Assam	5,082
3.	Bihar	2,377
4.	Punjab	2,299
5.	Uttar Pradesh	2,100

2. MATERIALS AND METHODS:

In this study, the assembled water of identified iron concentration was conceded through the inlet pipe. Inside the bottle cylinder, unlike adsorption media of quantified thickness were located with appropriate gravel support. Then post filtration, the filtered water was composed through the outlet part in a beaker and the ending concentration was restrained in the Atomic Absorption Spectrometer. The rate of filtration was noted and for each adsorption media, three or four samples were tested and regular concentration was measured for analysing efficiency of filters.

Materials used and Preparation of Adsorption Media:

Possibility and efficiency of utilization of the herbal as an adsorbent for heavy metal adsorption in polluted water has been worked upon. Following materials were used in removal of iron from water.

• Sand:

Fine sand and gravel are natural glacial deposits great in silica content and low in soluble calcium, magnesium and iron compounds, and is very useful in removal of sediments. But here it is used for iron removal from drinking water. Sand passing through 600 Micron sieve is used.

• Tulsi Leaves Powder:

Tulsi, Holy basil or *Ocimum Sanctum* Linn. leaves in drinking water are used for purification and medication. It 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 Ayurveda. It chemically contains many nutrients and other biological actives. It can remove fluoride levels in drinking water. It has also been found in fighting fluorosis. Tulsi leaves powder, as in figure 1, was used for removal of iron from water.

Fig 1 Tulsi leaves powder

- Neem Leaves Powder:

Neem or *Azadirachta indica* leaf powder, as in figure 2, was taken for removal of toxic elements from water. Here, two methods were adopted. First method was only neem powder used but second method was mixed thoroughly with calcium hydroxide in 1:10 ratio.

Fig 2 Neem leaf powder

- Rice husk:

Rice husk are the hard protection of grains of rice. Around 20% of the paddy weight is Husk. The chemical composition of Rice 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 %. After burning, most evaporable components are slowly lost and the silicates are left. 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 Rice Husk

- Aluminum hydroxide coated Rise husk Ash:

Rice husk ash was generated by burning rice husk. Cellulose and lignin were removed by burning and leaving behind silica ash. Ash was produced by controlled temperature and

environment of burning process in muffle furnace at a temperature of 500^0C for 3 hours. Ash was first soaked with 0.01 N HCl. Dried ash 100 gm., 0.6 M of aluminium salt as Aluminium 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 273^0C.This was used as an adsorbent along with sand as a base material.

Fig.4 RHA coated with Al (OH) 3
Fig 5 Rice Husk Ash

- Sugarcane Bagasse:

Bagasse is sugarcane fiber waste left after juice extraction. It contains mainly cellulose, hemi cellulose, pentosans, lignin, sugars, wax and minerals. Sugarcane bagasse 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 105^0C for 3 hours and for 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 100 grams bagasse. This was used as an adsorbent along with sand as a base material.

Fig 6 Sugarcane bagasse

Procedure

- Leaves of neem and tulsi were collected from the nearby area.
- Sugarcane bagasse was collected from the sugarcane juice stores.
- Rice husk is collected from the local village and burnt in a way that it does not get turn complete to ash, only burnt from top surface.
- Sand, Sponge and nylon cloth were availed.
- All the materials were segregated and washed with tap water followed by distilled water, sieved and dried before use.

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

Since all the materials are disinfected and dried, all the materials are layered one by one, as in figure 7.

- Starting from botton, Nylon cloth-Sponge-Sand-Ash-Sand-Sugarcane Bagasse-Neem leaf-Tulsi leaf-Sponge.
- After placing the material in layered form, pour the clean water for numerous times till the clean water come.
- Collection of Water Sample, from Rapti River.
- Pond water is collected from Ramgarhtal, Gorakhpur.
- The samples were stored in pre cleaned, autoclaved plastic cans and immediately used for experiment.
- Treated water samples underwent different test to check its quality.

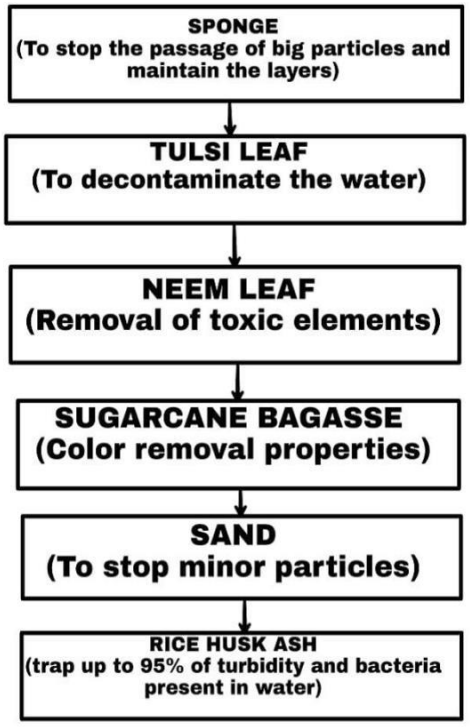

Figure 7 Layering of materials

3. RESULTS AND DISCUSSIONS:

Tulsi leaves powder:

The results were obtained in removal of iron by using Tulsi powder as mentioned in table 4. The rate of filtration and the effectiveness in removing iron are mentioned here. The initial iron concentration was 1.053ppm and better removal iron (in %), but rate of filtration in this case was lesser. The results are shown in Table 4 and Figure 5.1.

Table 4 Results of filtration in Tulsi leaves powder

Sample.No	Thickness of Sand Layer (in cm)	Amount of Tulsi Leaf powder (in cm)	Initial iron content (ppm)	Final iron content (ppm)	Rate of filtration (ml/min)
1.	Top layer=2cm Bottom=3cm	50gram	1.042	0.972	185
2.	Top layer and bottom+2cm	40gram	1.042	0.987	238
3.	Top layer and bottom =3 cm	40gram	1.042	0.976	192

Neem leaf powder:

The results are obtained in removal of iron by using Neem powder as mentioned below. 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 and Figure 5.2.1.

Table 5 Results of filtration in Neem leaves powder

Sample.No	Thickness of Sand Layer (in cm)	Amount of Neem Leaf powder (in cm)	Initial iron content (ppm)	Final iron content (ppm)	Rate of filtration (ml/min)
1.	Top layer=2cm Bottom=3cm	50 gram	1.315	0.702	200
2.	Top layer and bottom =2cm	40 gram	1.315	0.878	227
3.	Top layer and bottom =3 cm	40 gram	1.315	0.676	208

Table 6 Results of filtration in Neem leaves powder mixed with chuna

Sample.No	Thickness of Sand Layer (in cm)	Amount of Tulsi Leaf powder	Initial iron content (ppm)	Final iron content (ppm)	Rate of filtration (ml/min)
1.	Bottom layer =3cm	100 gram	1.316	0.575	140
2.	Bottom layer =2cm	75 gram	1.316	0.630	153
3.	Bottom layer =3 cm	50 gram	1.316	0.674	167

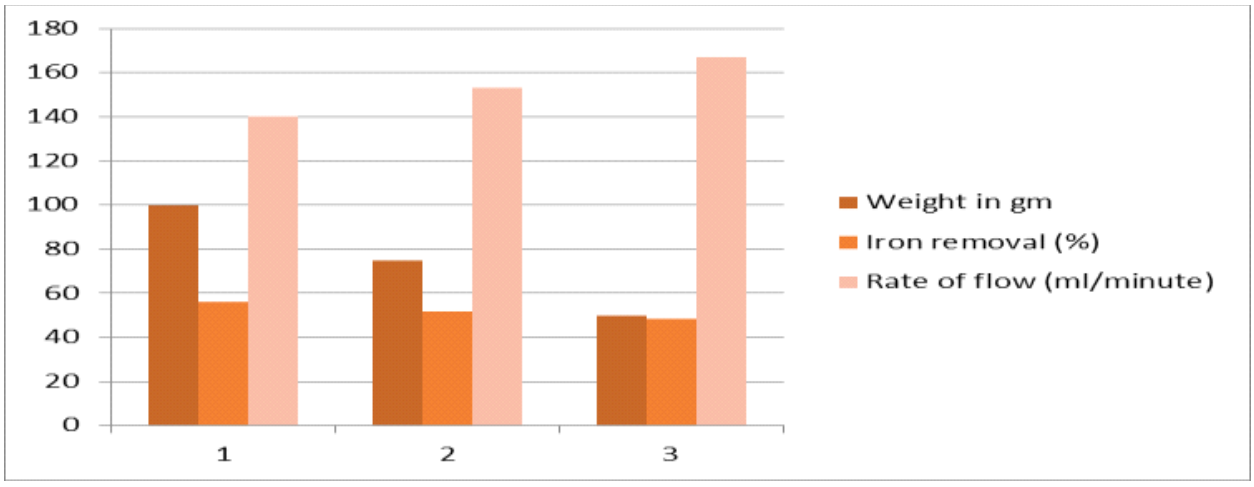

Fig 8 Iron removal with Chuna mixed Neem powder

Rice husk:

The results are obtained in removal of iron by using rice husk as mentioned above. 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 7 and Figure 8.

Table 7 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	100 gram	1.593	160
2.	600	75 gram	1.569	160
3.	600	50 gram	1.671	160

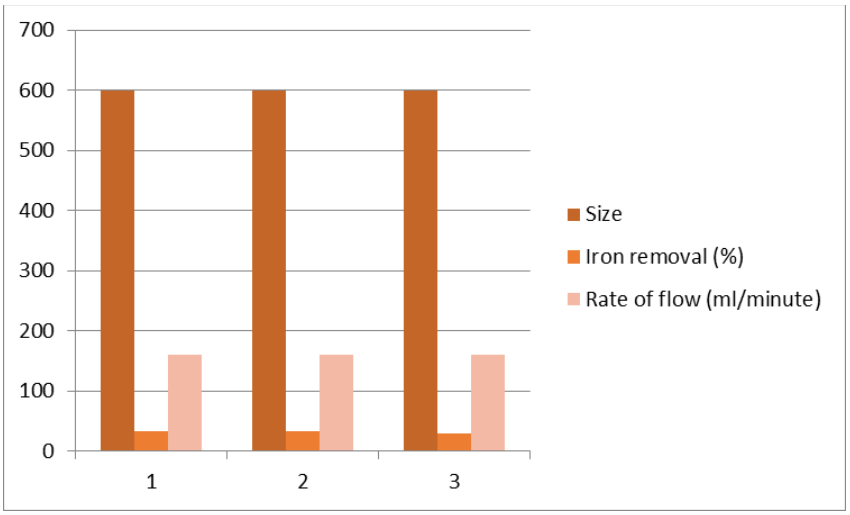

Fig 9 Iron removal in Rice husk

Aluminium hydroxide coated Rice husk ash:

The results are obtained in removal of iron by using Al (OH) 3 coated Rice husk ash as mentioned in 9. 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 8 and Figure 10.

Table 8 Results of filtration in modified rice husk Sample

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

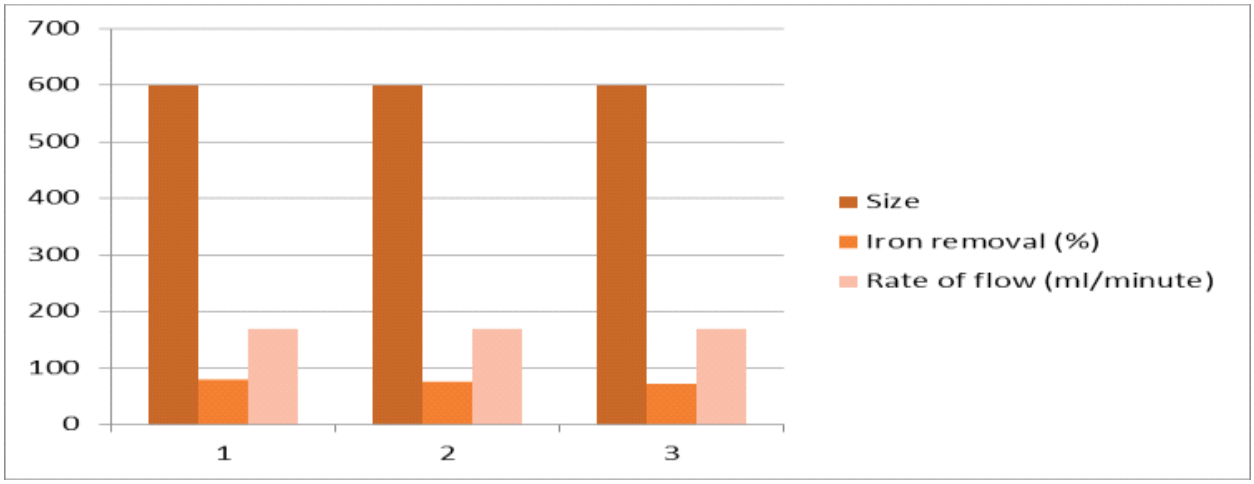

Figure 10: Iron removal in Al(OH)3 coated rice husk

Sugarcane bagasse :

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.

Table 9 Results of filtration in Sugarcane bagasse

Sample.No	Amount of Sugarcane Baggase (gram)	Initial Iron content (PPM)	Final iron content (ppm)	Rate of filtration (ml/min)
1.	100	2.378	1.369	220
2.	100	2.378	1.589	220
3.	100	2.378	1.297	220

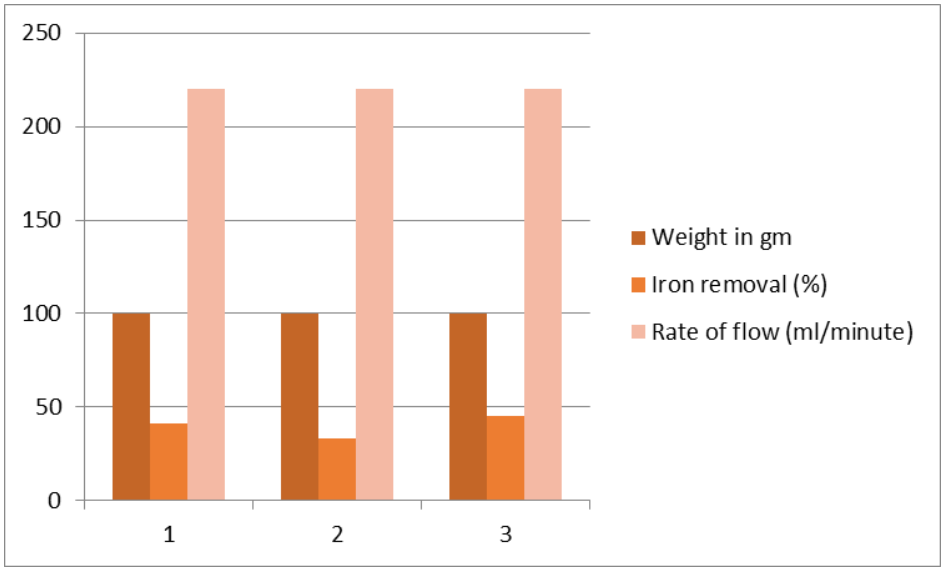

Fig 11: Iron removal in Sugarcane Bagasse

Comparison of result:

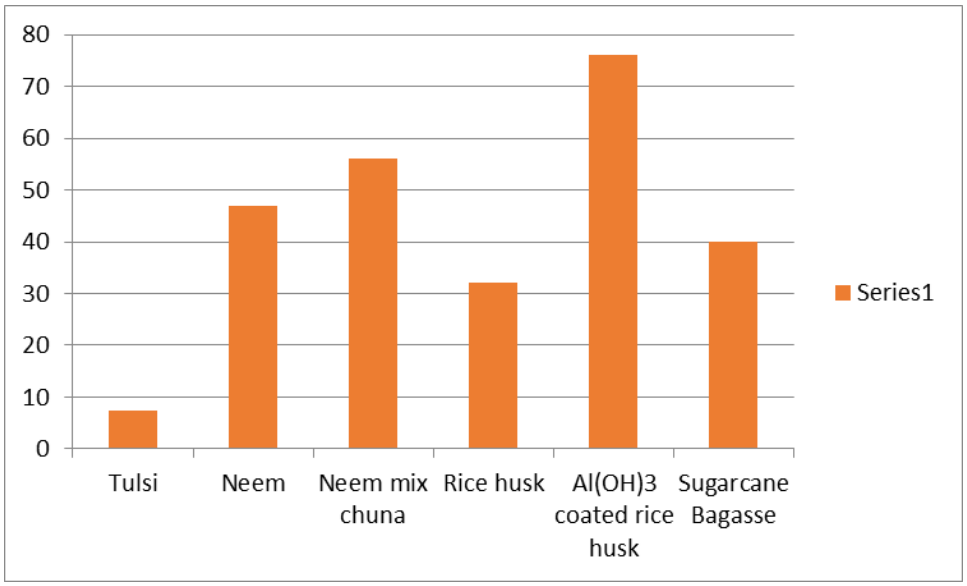

Fig 12 Variation of % removal of irons with different herbal used

Figure 12, in x-axis indicated:

• In Tulsi leaves powder, better result obtained in sample1 which removed the iron concentration 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 9 Material cost of different adsorbent media used in experimentation

S.No	Material	Amount used for experiment (kg)	Rate per kg In rupees	Total cost In rupees
1.	Sand	0.9	15	13.5
2.	Tulsi leaf powder	0.2	300	60
3.	Neem leaf powder	0.3	150	45
4.	Rice husk	0.6	20	12
5.	Aluminum sulphate	0.05	20	1
6.	Sugarcane bagasse	0.2	20	4
7.	Bottle	-	-	2

CONCLUSION:

Adsorption being the meekest and inexpensive technique for iron removal has numerous rewards, like extended filtration runs, smaller evolving time, and restored filtrate eminence. But the only limitation is back wash water condition is necessary for the filter media to run efficiently. Sand being the economical 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 found to be a good adsorbent in removal of iron. Neem leaf powder mixed with Calcium hydroxide, proved to be good result in removal of iron as compared to

untreated Neem leaves powder. As modified Neem powder decreases the rate of filtration. Aluminum hydroxide coated RHA also proved to be a good adsorbent in removal of iron. 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. In 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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