USE OF VARIOUS NATURAL ADSORBENTS FOR IRON REMOVAL FROM WELL WATER AND THEIR COMPARISON

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Abstract –

Sustainability of good health depends upon the purity of water. However groundwater may be exposed towards to contamination by various anthropogenic activities such as agricultural, domestic and industrial. Groundwater quality problem are typically associated with high level of iron concentration. The normal drinking water contains permissible limit of iron concentration 0.3mg/L but the Dharmasala, Kannur district contains 1.4mg/L of iron concentration. In the present study arecanut husk, mahogany leaves, curry leaves and wheat husk have been selected as adsorbent for removal of iron.The parameters such as effect of adsorbent depth and retention time were studied by column adsorption study.

Keywords: *Arecanuthusk, Mahogony leaves,Curry leaves,Wheat husk,Iron, Adsorption*

I.INTRODUCTION

Water is a basic need, People need water to survive. Water holds the key to sustainable development. Safe water is one way to go to better living and environment. As the world population increases more people using up this limited resource. 1 in 10 people lacks access to safe water. According to United Nations approximately 3.5 million deaths related to inadequate water supply, sanitation or hygiene occur each year. Poor water quality incurs many economic costs: degradation of ecosystem services; health-related costs; impacts on economic activities such as culture, industrial production and tourism; increased water treatment costs; and reduced property values among others. Access to safe water and adequate sanitation services has proven to be one of the most efficient ways of improving human health.

According to environmental campaign organization WWF pollution from toxic chemicals threatens the life in this planet. Every ocean and every continent from the tropics to the once pristine Polar Regions are contaminated. Many substances that are hazardous to human health can enter water supplies. Chemical waste from the factories is sometimes dumped in to the rivers, lakes or directly to the ground. Pesticides and fertilizers applied to the farmland enter surface water and ground water in large quantities. According to the latest assessment by water aid (an international organization working for sanitation and hygiene) an alarming 80% of India‟s surface water is polluted. Inadequate sanitation facilities poor septage management and near absence of sanitation wastewater policy are primary reason responsible for ground water and surface water pollution.

Iron is second most abundant metal and fourth most abundant element on Earth. Iron exists in two forms, soluble ferrous iron (Fe2+) and insoluble ferric particulate iron (Fe3+). The presence of iron in natural water may be attributed to the dissolution of rocks and minerals, acid mine drainage, landfill leachate sewage or engineering industries. Iron in water is generally present in the ferric state. The concentration of iron in well aerated water is seldom high but under reducing conditions, which may exist in some groundwater, lakes or reservoirs and in the absence of sulphate and carbonate, high concentrations of soluble ferrous iron may be found. The presence of iron at concentrations above 0.1mg/l will damage the gills of the fish. The presence of iron in drinking water supplies is objectionable for a number of reasons. Under the pH condition existing in drinking water supply, ferrous sulphate is unstable and precipitates as insoluble ferric hydroxide, which settles out as a rust coloured silt. Such water often tastes unpalatable even at low concentration (0.3 mg/l) and stains laundry and plumbing fixtures. Iron is an essential element in human nutrition. Iron is one of the major impurities present in many sources of water. Iron deposited in distribution system may promote the growth of microorganisms leading to high contamination in drinking water. Natural sources of iron may include weathering of ironIron give water an unpleasant taste, odour and colour. Iron causes reddish-brown stains on laundry, porcelain, dishes, utensils, glassware, sinks, fixtures and concrete.

Determination of iron is very important in explorations of new water supplies, particularly from bore well and other surface water sources. The drinking water can be rejected only on the basis of excess iron present in it. Iron can be toxic to freshwater aquatic life above 1 mg/l and may interfere with fish uptake of oxygen through their gills above 0.3 mg/l. Therefore, pre-concentration or removal of iron from aqueous solutions is a matter of great concern in analytical and environmental work.

People of Dharmashala in Kannur facing serious drinking water problems due the presence of iron in well water. The excessive iron content in drinking water will leads to unusable. Here in this study I am trying to introduce natural adsorbents Arecanut Husk, wheet husk. Mahogony leaves, curry leaves for the removal of iron from drinking water. The water samples are collected from Dharmashala in Kannur.

II MATERIALS AND METHODS

2.1 Materials

2.1.1 Collection of Samples

Samples were collected from Dharmashala of Kannur district. Dharmashala is a town and headquarters of the Anthoor Municipality in kannur district of the North Malabar region in south Indian state of Kerala. Dharmashala is an important educational and industrial hub in kerala.The faimous kairali TMT steel industry located in this area. A large number of migrant labours from various other states are working in the industrial development area in Dharmashala .People in Dharmashala are facing serious drinking water problems due to the presence of iron in the water. Presence of excessive iron content in drinking water leads to unusable. People in Dharmashala can't use well water directly without any treatment. Some families in Dharmashala use filters for filtering the well water and is used for bathing, washing etc. This filtered water is again filtered and is used for drinking purpose. Use of this water causes many health problems to the people of the locality.

Three well water samples are collected from Dharmashala for this study. Water samples were collected in bottles. Before filling the samples in bottles, bottles are washed thoroughly with distilled water and also washed with the samples collected. 10 litres of each samples were collected for the study.

Fig 2.1: Sample 1

Fig 2.2:Sample 2

Fig 2.3:Sample 3

2.1.2 Arecanut Husk

Arecanut husk is selected as an adsorbent for iron removal from well water . In India, areca (betel nut, Areca catechu) husk is a biomass widely available, especially in the southern part of the country. Arecanut is the kernel obtained from the fruit of the areca palm tree and over 0.38 million tonnes of the fruit is harvested annually in India. The nut is of commercial importance and is processed by boiling. The husk of the fruit is removed and it has no other traditional use. Left in piles to dry, it is often a nuisance to the producer/processor. The husk is fibrous (hard and soft fibres) and is predominantly composed of cellulose with varying proportions of hemicellulose, lignin, pectin and protopectin.

Fig 2.4:Arecanut Husk

2.1.3 Mahogony leaves

Mahogony leaves are selected as absorbent for the present study. The Swieteniamahagoni is native to southern Florida, the Caribbean, and the West Indies. This is the 'original' mahogany tree. The Swieteniahumilis is the dwarf mahogany, which only grows to about 20 feet tall. Typically the mahogany tree can grow up to 150 feet high, and 12 feet in diameter. But the average diameter is only about 5 feet. Often the first limb is over 50 feet up. The bark has a dark color and is fairly smooth. The leaf is a compound leaf, so there are several distinct leaflets on a single stem. The tree grows small, purple-yellow flowers. Mahogany has a straight, fine, and even grain, and is relatively free of voids and pockets. Its reddish-brown color darkens over time, and displays a reddish sheen when polished. It has excellent workability, and is very durable. Historically, the tree's girth allowed for wide boards from traditional mahogany species. These properties make it a favorable wood for crafting cabinets and furniture .Among all natural adsorbent ML has high potential to remove the heavy metals. The potentiality of mahogony has also been widely studied by different researchers for solving most of the problems related to agriculture, environmental pollution public health, population control.

Fig 2.5: Mahogony leaves and powder

2.1.4 Curry leaves

The scientific name of the curry plant is Murraya Koenigii Spreng and it belongs to theRutaceae family. The plant is native to India and is usually found in tropical and subtropical regions. It is cultivated in various other countries such as China, Australia, Nigeria and Ceylon. Height of the plant ranges from small to medium. The most useful parts of this plant are the leaves, root and the bark. The leaves, with their vast herbal properties, are used in various local cuisines across India and other parts of Asia as flavouring agents. CL resemble 'neem' or Indian lilac and their name in most Indian languages translates to 'sweet neem'.

Fig. 2.6 curry leaves and curry leaves powder

2.1.5 Wheat husk

Wheat is one of the most important grains with the highest sustenance value in the world, it has a remarkable consumption ratio due to its ease of cultivation. Its ability to be converted into a variety of foods, its multipurpose use, and its role in the human diet. Every year, approximately 600 million tons of wheat is produced around the world. A typical wheat kernel consists of a husk and seed. The total volume of husk stands for approximately 5% of the kernel,which consists of 6% protein,2%ash,20% cellulose,and 0.5%oil and non-starch polysaccharides.The WH contains in its structure carbon,oxygen,silica,potassium and low levels of sulphur,phosphor,sodium,magnesium and aluminium.

Fig 2.7 Wheat husk and wheat husk powder

2.2 Methods

2.2.1 Experimental Setup

2.2.1.1 Adsorption Unit

A column apparatus of size 60 cm length and 3 cm diameter is used and an overhead tank and collection tank is provided for this experiment. An outlet was provided at the bottom of tank. Experiment is conducted by placing the adsorbent in column apparatus singly at first, then combination of two adsorbents and finally combination of all together. At first add distilled water into the apparatus and kept it for several time with outlet closed for dilute the adsorbent after several time open the outlet for removing the excess water in the column apparatus. From the overhead tank allow to pass the waste water into the apparatus, keeping suitable retention period with outlet closed, after the retention period open the outlet and collect the water from the collection tank.

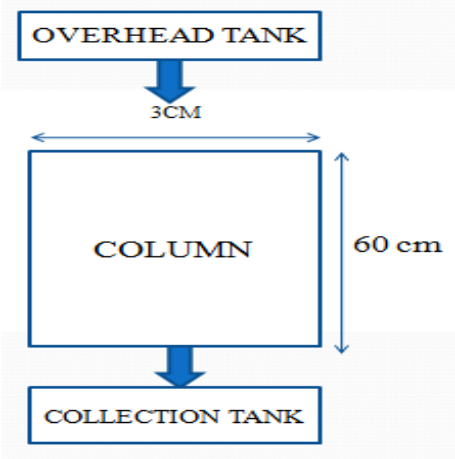

Fig: 3.9 Layout of Experimental Setup

2.1 Physicochemical characterization of adsorbent

Characteristics	Desirable limits as per IS 10500:2012	Sample 1	Sample 2	Sample 3
Turbidity	1	4.7	5	4
Ph	6.5 to8.5	6.98	6.58	6.92
Electrical conductivity		350	445	185
Acidity		81	19	13
Alkalinity	200	Nil	74	70
Total Dissolved solids	500	258.5	385.6	94.5
Total Hardness as CaCO3	200	54	180	44
Calcium(Ca)	75	14.41	68.14	10.42
Magnesium(Mg)	30	4.37	2.47	4.37
Chloride as(Cl)	250	24.11	18.43	9.93
Fluoride as(F)	1	Nil		Nil
Iron as(Fe)	0.3	1.4	1.2	0.4
Nitrate as(NO3)	45	20	Nil	Nil

Table 3.1 shows the Drinking water characteristics before treatment. The value of Iron in sample 1 is excess also in sample 2 and sample 3 this value is above permissible limit.all other parameters are within the limit. Therefore the water should treat before

III. RESULTS AND DISCUSSIONS

3.1 Experiments Using Samples with Varying Adsorbent Depth

The experiments are carried out using the samples collected. From the experimental studies it can be concluded that the effect of combination of Arecanut husk, mahogany leaves ,curry leaves and wheat husk give maximum treatment for iron removal from well water. The following are the result obtained.

3.1.1 Effect Of Adsorbent Depth On Sample 1

Three samples are tested using the prepared adsorbents Arecanut husk carbon, mahogany leaves, curry leaves, wheet husk. The sample 1 contains 1.4mg/l iron. Table. 4.1 shows the variation of percentage iron removal.

Table 3.1 Effect of adsorbent depth on sample 1 using selected adsorbets

Adsorbent depth	Percentage iron removal (%)				
	Arecanut husk	Mahogony leaves	Curry leaves	Wheat husk	Combination of Arecanut,Mahogony,curry leaves and wheat husk
10 cm	72.22	32.22	15.8	56.6	71.58
20 cm	74.67	34.45	33.3	63.3	76.12
30 cm	82.22	54.43	40.0	65.5	83.31
45 cm	86.66	64.44	57.7	70.0	89.80

Table 3.1 shows result of Arecanut husk, mahogany leaves, curry leaves, wheat husk and combination of all of this as adsorbent with varying depth for testing the samples 1. From the table.it can be concluded that, the value of parameter have been decreased after adsorption. This experiment shows that the treatment with combination of arecanut husk, mahogany leave, and curry leaves and wheat husk can effectively removing the excess iron content. In sample 1 collected containing1.4mg/l iron during the treatment with combination of selected adsorbents the iron content in the sample is reduced to 0.15mg/l. As the depth of adsorbent increases the value of the iron decreases. The maximum removal efficiency is obtained at 45 cm of depth of adsorbent.

3.1.2 Effect Of Adsorbent Depth On Sample 2

Three samples are tested using the prepared adsorbents Arecanut husk carbon, mahogany leaves, curry leaves, wheet husk. The sample 2 contains 1.2mg/l iron.Table. 4.2 shows the variation of percentage iron removal

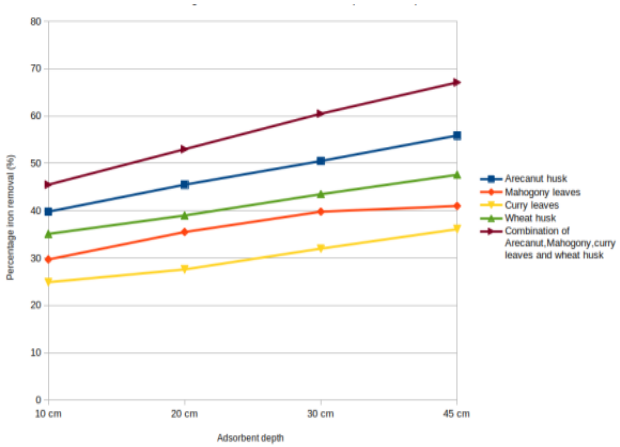

Fig.3.1 Percentage iron removal vs adsorbent depth

Table 3.2 Effect of adsorbent depth on sample 2 using prepared adsorbent

Adsorbent depth (cm)	Percentage iron removal (%)				
	Arecanut husk	Mahogony leaves	Curry leaves	Wheat husk	CombinationofArecanut,Mahogony,curry leaves and wheat husk
10 cm	70.7	60.71	13	64	72.85
20 cm	75.7	63.57	15	73	80.71
30 cm	85.1	67.14	35	75	85.00
45 cm	87.1	78.57	55	78	89.28

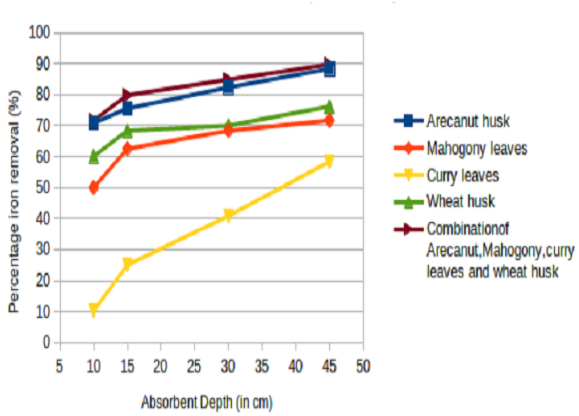

Fig.3.2 Percentage iron removal vs adsorbent depth

3.1.3 Effect Of Adsorbent Depth On Sample 3

Three samples are tested using the prepared adsorbents Arecanut husk carbon, mahogany leaves, curry leaves, wheet husk. The sample 3 contains 0.9mg/l iron.Table.4.3 shows the variation of percentage iron removal.

Table 3.3 Effect of adsorbent depth on sample 3 using prepared adsorbents

Adsorbent depth	Percentage iron removal (%)				
	Arecanut husk	Mahogony leaves	Curry leaves	Wheat husk	CombinationofArecanut,Mahogony,curry leaves and wheat husk
10 cm	72.2	32.22	15	56	71.58
20 cm	74.6	34.45	33	63	76.12
30 cm	82.2	54.43	40	65	83.31
45 cm	86.6	64.44	57	70	89.80

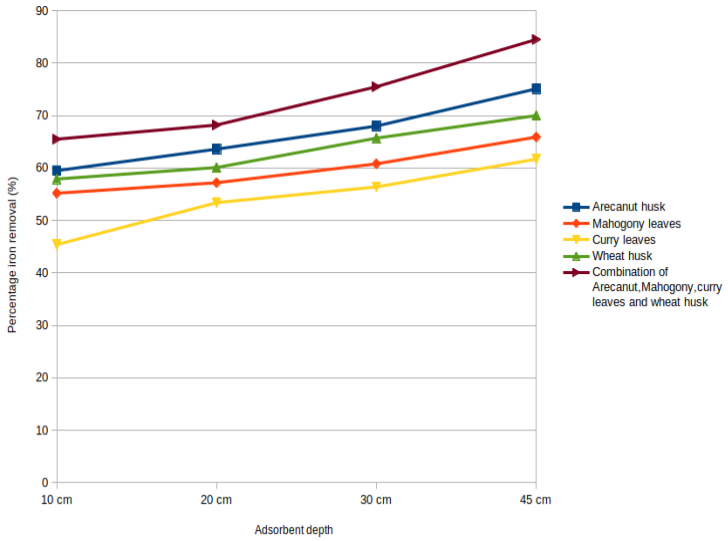

Fig 3.3: Percentage iron removal vs adsorben depth

3.2 Experiments Using Samples with Retention Time

The optimum time is found out from the optimum depth. The optimum depth that has been obtained is 45cm. The optimum depth was obtained by conducting tests under varying depths of 10cm, 15cm, 30cm and 120 minutes. The following are the result obtained.

3.2.1 Effect of Retention Time on Sample 1

Three samples are tested using the prepared adsorbents Arecanut husk, mahogany leaves, wheat husk and curry leaves. The sample 1 contains 1.4mg/l iron. Table 4.4 shows the variation of percentage iron removal.

Table 3.4 Effect of Retention time on sample 1 using selected adsorbents

Retention time(Min.)	Percentage iron removal (%)				
	Arecanut husk	Mahogony leaves	Curry leaves	Wheat husk	Combination of Arecanut,Mahogony,curry leaves and wheat husk
30	85.7	65.71	34	70	77.85
60	87.14	72.14	61	77	87.00
90	90.00	77.85	70	82	90.10
120	94.25	79.28	75	87	96.42

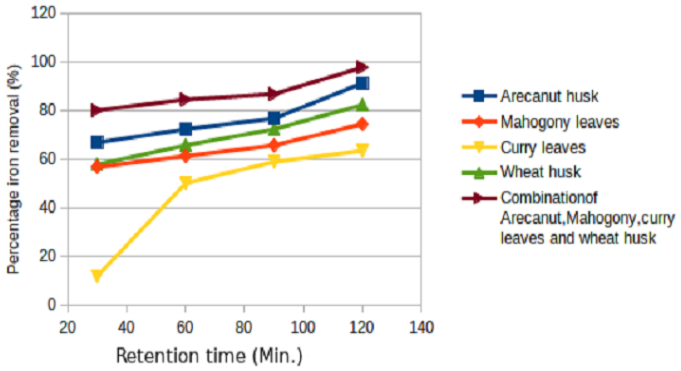

Fig.3.4 Percentage iron removal vs retention time

3.2.2 Effect of Retention Time on Sample 2

Three samples are tested using the prepared adsorbents Arecanut husk, mahogany leaves, wheat husk and curry leaves. The sample 2 contains 1.2mg/l iron. Table 4.5 shows the variation of percentage iron removal.

Table 3.5 Effect of Retention time on sample 2 using selected adsorbents

Retention time(Min.)	Percentage iron removal (%)				
	Arecanut husk	Mahogony leaves	Curry leaves	Wheat husk	CombinationofArecanut,Mahogony,curry leaves and wheat husk
30	73.33	65.00	27.5	62.5	80.83
60	83.33	70.12	57.5	68.3	86.66
90	82.50	75.56	66.6	80.8	91.66
120	95.00	75.89	71.6	86.6	96.66

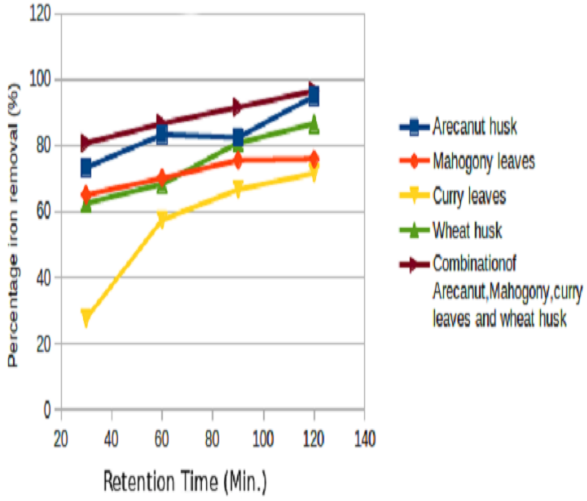

Fig.3.5 Percentage iron removal vs retention time

3.2.3 Effect of Retention Time on Sample 3

Three samples are tested using the prepared adsorbents Arecanut husk, mahogany leaves, wheat husk and curry leaves. Variation of percentage iron removal.

Table 3.6 Effect of Retention time on sample 3 using selected adsorbents

Retention time(Min.)	Percentage iron removal (%)				
	Arecanut husk	Mahogony leaves	Curry leaves	Wheat husk	CombinationofArecanut,Mahogony,curry leaves and wheat husk
30	66.66	56.76	11	57	80.00
60	72.22	61.21	50	65	84.44
90	76.66	65.55	58	72	86.67
120	91.11	74.34	63	82	97.67

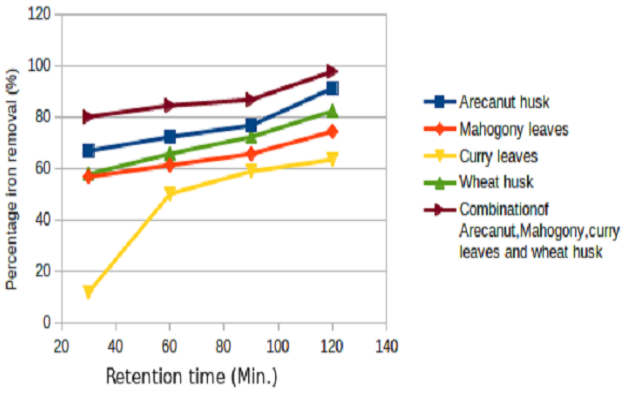

Fig.3.6 Percentage iron removal vs ret

IV.CONCLUSIONS

Adsorption is one of the fundamental process in physiochemical treatment of wastewaters. The advantage of adsorption method comparing with other system is that, it needs lower land area requirements, lower sensitivity to diurnal flow and concentration variations and to toxic substances, potential for significant heavy metal removal, greater flexibility in design and operation and organic waste removal.

This study has successfully revealed that the treatment with the combination of Arecanut husk,mahogany leaves,curry leaves and wheat husk can effectively removing the iron content in sample no 1 collected from near kairali TMT steel bars company, Dharmashala,Kannur district contain 1.4mg/l of iron . During the treatment with combination of selected adsorbents the iron content in the sample is reduced to 0.05mg/l. Similar, sample no 2 collected contain 1.2mg/l of lead reduced to 0.04 mg/l during the treatment. And sample no 3 contain 0.9mg/l of iron and is reduced to 0.03 mg/l during the treatment with combination of arecanuthusk ,mahogany leaves,curry leaves and wheat husk at 45cm depth and 120 minutes of retention period.So it can be concluded that the Percentage iron removal from for the drinking water is 96.42%,96.66% and 97.67% for sample no 1,2,3 collected from Dharmasala of Kannur district. Four adsorbents have significant effect on iron removal. Comparing the four adsorbents, the iron removal for arecanut husk is higher than that of wheat husk, mahogany leaves and curry leaves. Combination of Arecanut husk, mahogany leaves, curry leaves and wheat husk can effectively removing the iron content. Since Arecanut husk, mahogany leaves, curry leaves and wheat husk are easily available and ecofriendly it can be used for the removal of iron from water.

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