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Biosorption Behavior of *Hydrilla* Sp. and *Chara* sp. For Iron Removal from Aqueous Solutions in Godavari River, Nanded, Maharashtra, India

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Abstract

The absorption process is being widely used by various researchers for the removal of heavy metals from aqueous solutions. In recent years, the use of various natural products has been widely investigated as an alternative to the currently expensive methods of water treatment. Phytoremediation refers to a set of technologies that use different plants as a containment technique. The results from field trials indicated that it is a cost-saving technique compared to conventional treatment. Aquatic plants can be used for the removal of heavy metals. These bios sorbent have been examined for their capacity to sequester iron from an aqueous solution with contact time. The experiments were carried out by laboratory-prepared samples on a spectrophotometer. The present investigation has helped to understand the phytoremediation capacity of *Hydrilla* sp. and *Chara* sp. to remove iron metal from an aqueous solution. The present investigation of batch studies was conducted and the uptake of iron from aqueous solutions by *Hydrilla* sp. and *Chara* sp. were investigated thoroughly. The daily iron uptakes were recorded, analyzed the results were compared with other aquatic plants. This study revealed that these aquatic plants *Hydrilla* sp. and *Chara* sp. can be successfully used for heavy metal removal in the Godavari River of Nanded city.

Keywords: Iron adsorption, Phytoremediation, Aqueous solution, UV Spectrophotometer, *Hydrilla sp, Chara sp.*

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Introduction

Most water pollution doesn't begin in the water itself. Take the oceans: around 80 % of ocean pollution enters our seas from the land. Virtually any human activity can have an effect on the quality of our water environment. When farmers fertilize the fields, the chemicals they use are gradually washed by rain into the groundwater or surface waters nearby. Sometimes the causes of water pollution are quite surprising. Chemicals released by smokestacks (chimneys) can enter the atmosphere and then fall back to earth as rain, entering seas, rivers, and lakes and causing water pollution. That's called atmospheric deposition.

With billions of people on the planet, disposing of sewage waste is a major problem. According to 2004 figures from the World Health Organization, some 1.1 billion people (16 % of the world's population) don't have access to safe drinking water, while 2.6 billion (40 % of the world's population) don't have proper sanitation (hygienic toilet facilities); the position hasn't improved much since. Sewage disposal affects people's immediate environments and leads to water-related illnesses such as diarrhea that kills 3-4 million children each year. (According to the WHO, water-related diseases could kill 135 million people by 2020). In developed countries, most people have flush toilets that take sewage waste quickly and hygienically away from their homes.

The problem of sewage disposal does not end there. When you flush the toilet, the waste has to go somewhere and, even after it leaves the sewage treatment works, there is still waste to dispose of. Sometimes sewage waste is pumped untreated into the sea. In theory, sewage is a completely natural substance that should be broken down harmlessly in the environment: 90 % of sewage is water. In practice, sewage contains all kinds of other chemicals, from the pharmaceutical drugs people take to the paper, plastic, and other wastes they flush down the toilets. When people are sick with viruses, the sewage they produce carries those viruses into the environment. It is possible to catch illnesses such as hepatitis, typhoid, and cholera from the river and seawater (Dara, 2002).

Iron intake may be increased by vitamin C tablets because this vitamin reduces tertiary iron to binary iron in an iron deficit person. Iron is present as binary iron bound to hemoglobin and myoglobin or as tertiary iron in food. The body may particularly absorb the binary form of iron

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which is decreased by phosphates. Chemically iron (Fe) is the least reactive hence it is found in pure form. It dissolves in sulphuric (H_2SO_4) and hydrochloric (HCl) acids. It is a transition metal; with an average atomic weight of 55.845. In the periodic table, iron is the 26th element and a member of group 8 and period 4. Its melting point is 1,535°C and its boiling point is 2,750°C. The density of iron is 7.874 g/cm ^{3} (at 20°C) and its most common ions are Fe $^{2+}$ and Fe $^{3+}$ (Lee, 2008).

Iron (Fe) can be present in water in three forms named dissolved ferrous (Fe^{2+}), particulate ferric (Fe^{3+}), and colloidal (very small particles) which are difficult to settle and filter. Sometimes the four forms of iron commonly found in drinking water are ferrous, ferric, organic, and iron bacteria. The dominance of one form is dependent on the pH, Eh (redox potential), and temperature of the water.

If water is not appearing clear when first drawn from the water tap it may contain ferric iron or organic iron which colors the water. Ferric iron precipitates or settles out and organic iron does not settle out. Ian well water-insoluble iron oxide is converted to soluble ferrous iron. Ferrous iron is colorless but when reacts with air, it oxidizes readily forming reddish-brown solid particles that then settle out as ferric oxide. The reddish-brown hydrated oxides are formed from silvery color metal. Dissolved electrolytes accelerate the reaction mechanism as,

$$4\ Fe + 3\ O_2 + 6\ H_2O \rightarrow 4\ Fe^{3+} + 12\ OH^- \rightarrow 4\ Fe\ (OH)_3 \text{ or } 4\ FeO(OH) + 4\ H_2O$$

Usually, the oxide layer does not protect the iron from further corrosion but is removed so more metal oxides can be formed. Mostly iron (II) sulfate electrolytes are formed during corrosion by atmospheric SO_2. Iron (III) hydroxide often precipitates in natural waters.

Elementary iron dissolves in water under normal conditions. Naturally occurring iron oxide, iron hydroxide, iron carbide, and iron pentacarbonyl are water-insoluble. The water solubility of some iron compounds increases with a decrease in pH values. Other iron compounds may be more water-soluble. The water solubility of iron carbonate is 60 mg/L, iron sulfide is 6 mg/L and iron vitriol is 295 g/L. Many iron chelation complexes are water-soluble. Water-soluble Fe^{2+} compounds are different from water-insolubleFe^{3+} compounds. The latter are only water-soluble in strongly acidic solutions but water solubility increases when these are reduced to Fe^{2+} under certain conditions.

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Dissolved iron is mainly present as Fe $(OH)_2^+$ (aq) under acidic, neutral, and oxygen-rich conditions. Under oxygen-poor conditions, it occurs as binary iron. Under reducing conditions, iron exists in the ferrous state. Ferric iron is insoluble in the absence of complex-forming ions unless the pH is very low. On exposure to air or the addition of oxidants, ferrous iron is oxidized to the ferric state and may hydrolyze to form insoluble hydrated ferric oxide (Basset et al., 1978). The iron cycle means a reduction of tertiary iron by organic ligands and oxidation of binary iron in surface waters by a process of photocatalysis. The higher content of iron in sediments than in river water may be attributed to the precipitation of iron as insoluble hydroxide under alkaline conditions of water (Strumm and Morgon, 1970).

Methodology

Study Area

For the present study, the Nanded city has been selected. Nanded district is part of the Marathwada region in Maharashtra. For the present study and around the area of Nanded city is selected. Nanded city is situated on the bank of the Godavari River. Presently the increasing urban population and due to it also increasing urban water demand for drinking and sanitation purposes only. This will be an ultimate load on the water quality deterioration in the mainstream Godavari River which is the best and ultimate source of drinking and utilization purpose in the Nanded city.

Some major constituents of water are oxygen, carbon dioxide, carbonate, acidity, and metals like calcium, sodium, potassium, magnesium. Anions like chloride are constituents of body fluids and are essential for life. Elements such as Fe, Cu, and Zn are essential for life, and elements like Pb, Cd, and Hg have been introduced into our bodies by the food chain as a result of industrial activity. Some other elements such as Mn, V, Cr, Mo, Se, Te, etc. have been found to be beneficial at a low level and toxic beyond the permissible limit and they tend to affect the metabolic activity. Hence, detection and quantification of metals are extremely important. Keeping these facts in view, water samples were analyzed and the values obtained were compared with the standards prescribed by WHO (Stanley, 1979).

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This research was one of the attempts to improve wastewater quality by means of a natural way of purification of Sustainable development via wastewater biosorption behavior of *hydrilla sp*. and *Chara sp*. for iron removal from aqueous solutions in Godavari River, of Nanded city, Maharashtra. Water quality is a major factor in determining the welfare of society. The presence of waterborne toxic substances in drinking water is a great health hazard.

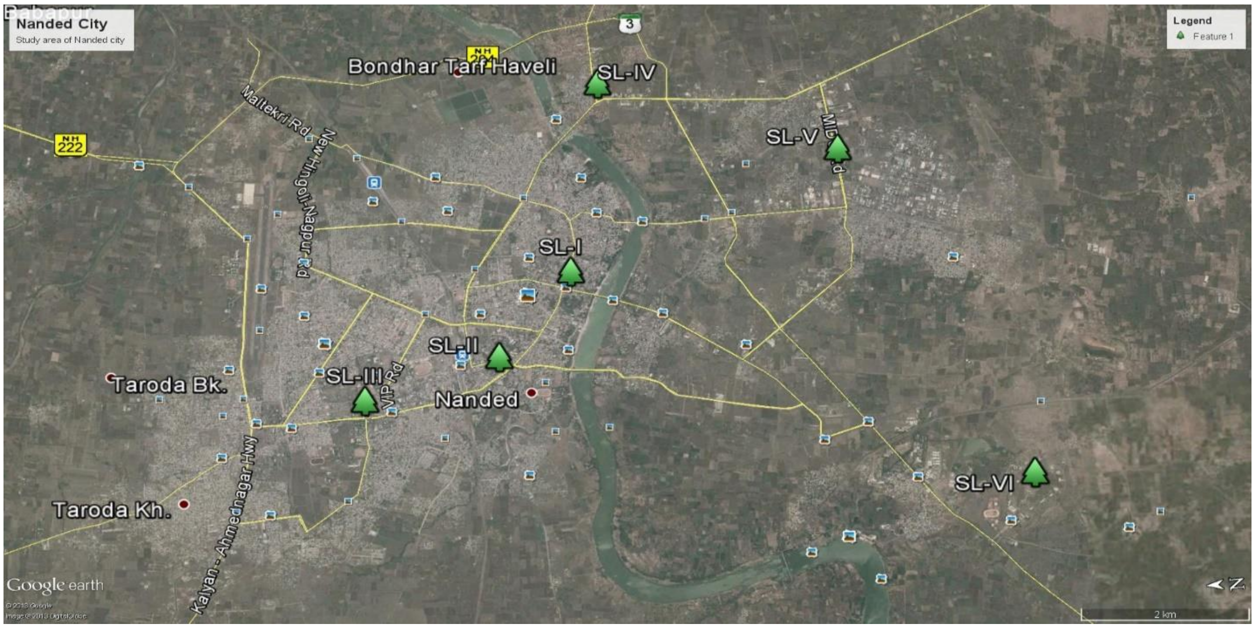

Figure: 1: Google Image Showing the Study Area in Nanded City.

Sampling

As the dam is a large surface occupied water body. Samples are collected from all sides and analyzed thoroughly in the laboratory. Nearly three sampling stations were selected to analyze heavy metal content in the water of the Godavari River. The selected water sampling sites are of four types two from upstream and two from downstream was investigated for investigation.

Estimation of Iron

Place 100 ml of well-shaken sample in a beaker. Add 5 ml of 1+1 HCl to reduce the volume to 40 ml on a hot plate. Cool it and add Potassium permanganate solution drop by drop until the pink color persists for at least 5 minutes. Make up the volume to 50ml. with distilled water. Pipette

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out 1 ml, 2 ml, 3 ml, 4 ml, 5 ml, 6 ml, 7 ml, 8 ml, 9 ml, and 10 ml standard iron solution in Nessler's tubes. Add 1ml dilute HCl and 2 drops of Potassium permanganate mix up well and makeup to the mark. Add to the standard and sample 1 ml of Thiocyanate solution and mix well. Pale yellow to brown yellow color will appear. Find out the absorbance at 510 nm on a Spectrophotometer. Express the result in mg/L of Iron (Sandell, 1959).

Iron Removal Methods

Iron removal from water is mostly carried out in drinking water preparation because mineral water contains high amounts of iron ions. These influence water color, odor, and turbidity. It is removed by a water softener (cation exchange), aeration, oxidizing (catalyst) filter, chlorination and filtration, flocculation, oxidation, and chemical precipitation, phosphate treatment, zeolite process, and biosorption methods. Iron is removed to some extent by the lime-soda process which removes color due to iron to a very small extent. The zeolite process is very costly which also moreover formed by iron. Activated carbon treatment removes the test of water caused by iron. By oxidation of binary iron to tertiary iron removed from wastewater.

Hydrolysis causes flake formation which can be then removed by sand filtration. Oxidation may be achieved by the addition of oxygen or other oxidants like chlorine, potassium permanganate, etc. The rate of reaction depends upon pH values and is slower under acidic than under alkaline conditions. To speed up the reaction under acidic conditions, the water may be aerated for carbon dioxide removal and pH recovery. This total reaction results in acid formation and thereby diminishes itself. Iron is often reduced together with manganese. Ion exchangers are applied to remove iron but this is not very suitable for removing high iron concentrations (Rangwala, 2000).

Results and discussion

This identified two species that were most useful to removal for iron content from water in the Godavari River in the Nanded city. This observation was noted after the long investigation of one-year data of the same species in the wastewater from the Godavari River in the Nanded city. The iron concentration in the month of March 2021 was found to be highest i.e., 1.8 mg/L and lowest

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0.0 mg/L in the month of June 2021 at sampling station-1. The sampling station-2 showed the maximum 1.7 mg/L concentration in the month of March 2021 and a minimum of 0.0 mg/L in the month of June 2021. The sampling station-3 showed the maximum 1.6 mg/L concentration in the month of March 2021 and a minimum of 0.0 mg/L in the month of June 2021.

The iron concentration was estimated highest at 1.6 mg/L in the month of November 2021 and the lowest 0.0 mg/L in the month of July, August, September 2021, and June 2021 at sampling station-1. The sampling station-2 showed the maximum 1.6 mg/L concentration in the month of November 2021 and a minimum of 0.0 mg/L in the month of July, August, September 2021, and June 2021. The sampling station-3 showed the maximum 1.8 mg/L concentration in the month of November 2021 and a minimum of 0.0 mg/L in the month July, August, September 2021, and June 2021.

This identified two species that were most useful to removal for iron content from water in the Godavari River in the Nanded city. This observation was noted after the long investigation of one-year data of the same species in the wastewater from the Godavari River in the Nanded city.

Table 3.1: The monthly mean concentration of iron (mg/L) of Godavari River water from January 2021 to December 2021

Months	Sampling site (S_1)	Sampling site (S_2)	Sampling site (S_3)
July	0.1	0.15	0.2
August	0.4	0.3	0.2
September	0.5	0.35	0.2
October	0.6	0.4	0.2
November	0.2	0.25	0.3
December	1.8	1.47	0.15
January	1.3	1	0.7
February	1.4	1.1	0.8

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March	1.8	1.7	1.6
April	1.2	1.3	1.4
May	1.2	1.3	1.4
June	0	0	0

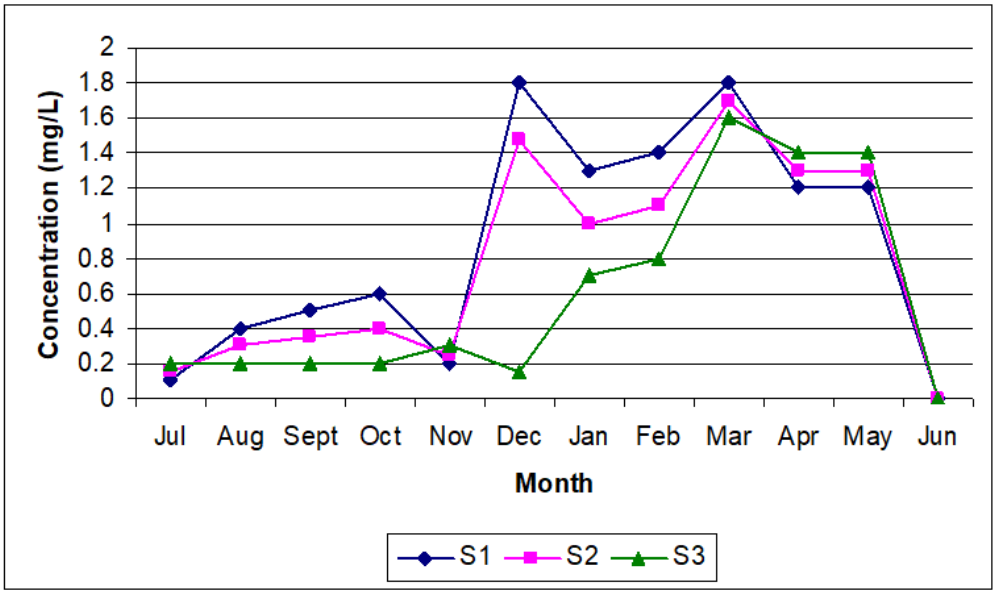

Figure 2: Monthly mean values of the iron content of Godavari River water from January 2021 to December 2021

Figure 3: Preparation of experimental setup for Iron metal and plankton of Godavari River water during an investigation

Akin and Unlu (2007), noted the heavy metal concentrations in water from the Tigris River of Turkey, from June 2000 to May 2001 from three study sites. The iron content recorded during the summer season was 0.15 mg/L at title I, 0.10 mg/L at site II and 0.085 mg/L at site III. Bujar et al. (2008), investigated the iron 0.04-0.58 mg/L from Shkumbini (Pena) river water, Tetova city in Jan. – Jun. 2002. The lowest value 0.04 mg/L were measured in April at Hisar's spa and the highest 0.58 mg/L in March at Tetova's City Hospital. The high content of metal due to throwing of rubbish and hospital wastes. Agtas et al. (2007), determined the concentration of heavy metals in the river Yildiz, Turkey from February to November 1993. The iron concentration minimum 0.91 to a maximum of 1.96 µg/L with the mean value of 1.38 µg/L observed in river water.

Banerjee and Ghosh (2010), investigated iron concentration varied from 0.206-2.01 mg/L with a mean value of 0.64 mg/L from Barakar and Damodar rivers, West Bengal, India during the period 2009-2010. Kundangar and Adnan (2001), studied the water quality of dredged and undredged zones of Dal Lake, Kashmir during Jan. 2000-Mar. 2000. The iron content at the dredged site ranged from 246 µg/L (360 days) to 1482 µg/L (7 days) with an average value of

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599.2 µg/L, while iron content at the underhedged site ranged from 104 µg/L (30 days) to 6275 µg/L (180 days) with an average value of 861.1 µg/L.

Dhanalakshmi et al. (2008), found iron concentration minimum 3.15 mg/L to a maximum of 4.05 mg/L from Sulur pond at Coimbatore, Tamilnadu from October 2001 to September 2002, the highest iron concentration due to washing of vehicles. Ajibade et al. (2008), studied the water quality of aquatic media of Kainji Lake, National Park, Nigeria for two years 2005-06. The mean iron content in dry and wet seasons is 2.627 and 6.007 mg/L in 2005 respectively. Also, the iron content 2.874 and 3.30 mg/L in dry and wet seasons in the year 2006 respectively from different selected sites of the river Oli, river Manyara, river Nuwanzurugi, and river Poto. Fandi et al. (2009), investigated iron content 0.0006 mg/L at inside and 0.0236 mg/L at outlet sites of King Talal dam, Jordan in July 2007.

Kamble et al. (2008), investigated iron concentration varied between 0.04 mg/L to 1.53 mg/L from Khadakwasala reservoir, Pune in the study period of July 2005-January 2006. The iron concentration of water was minimum during the beginning of the monsoon and maximum in the winter season. Suratman et al. (2009), did a preliminary study of the distribution of selected trace metals in the Besut river basin, Malaysia during August 2002, October 2002, and November 2002. The result for the iron content obtained in this study was 6.9 µg/L. Lee (2003), studied the contamination load on water affected by the Kongjujeil mine drainage, Republic of Korea. For the analysis of iron content in water, the samples were collected in August and December 1998. The iron concentration of the water sample ranges from 0.007 mg/L to 4.887 mg/L.

Khare et al. (2007), found iron content present in Khoumph-Niwari lake, Chattarpur (Madhya Pradesh) ranged between a minimum of 0.15 to a maximum of 0.19 mg/L from January 2005 to December 2005. Chatterjee et al. (2010), did the water quality assessment near an industrial site of Damodar River during the period of 2004 to 2007. In this study, the iron concentration was lower during post-post-monsoon higher during winter the values were ranging from 0.13 mg/L to 1.08 mg/L. Magaji et al. (2008), analyzed the concentration of heavy metals in the Karanja reservoir of Bidar from October 2001 to September 2003. In this assessment, they found the average iron values of 0.5854 mg/L, while minimum iron concentration was recorded as

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0.3218 mg/L during summer of 2003 and maximum iron concentration recorded was 1.303 mg/L during monsoon 2003.

Mahadev and Gholami (2010), detected mean of iron ranged from a minimum of 1.6 to a maximum of 5.6 ppm from different sampling locations of Cauvery River, Karnataka during October 2003-November 2008. Ashraf et al. (2010), observed iron concentration 0.18 mg/L to 0.51 mg/L from Varsity Lake, Kuala Lumpur, Malaysia. This study was carried out on 15 October 2009, 28 December 2009 and 16 February 2010 by selecting different sites from the lake. These observed values were compared with the permissible limit of 1 mg/L o Interim National Water Quality Standards (INWQS).

The concentration of iron ranged from 1.3-68.2 μg/L and 100-11000 μg/L in dissolved and particulate form in Gediz river, Turkey respectively. This study was carried out by Kucuksezgin et al. (2008) during August, October 1998, and February and June 1999. Nikhil and Azeez (2009), observed iron ranged from 0 to 0.2047 mg/L and 0-0.0144 mg/L with an average of 0.07 and 0.0032 respectively from Amparampalayam and Kumbidi site. In most of the sampling sites, the iron was absent during 1993-2003 of Bharathapuzha river, India.

The iron content minimum 35 μg/L to a maximum of 150 μg/L in the year 2005-2006 and a minimum of 67 μg/L and a maximum of 225 μg/L in the year 2006-2007 from surface water of upper basin of Bhoj Wetland, Bhopal. Higher concentrations of iron during the rainy season due to rainfall and run-off cause erosion, soil, silt, and wastewater discharged from nearby drains (Naik and Wanganeo, 2008). Shreshta et al. (2011), found iron 24 to 40 mg/L from different sampling sites in September 2006 from groundwater and 40 to 41 mg/L from river water samples. The iron content was lower than the standard value i.e., 0.3 mg/L from the Dhulikhel area, Nepal.

Conclusion

Iron and alloys are ubiquitous in the atmosphere and contain large amounts of water. The highest iron concentration in March 2021 is 1.8 mg / L. In many organizations, such as the World Health Organization, iron levels exceed the recommended drinking water limit (0.3 mg / L). The minimum ship investment record of one year i.e., from January 2021 to December 2021. The

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amount of iron in the water may vary depending on the geology of the area and other chemical parts of the vessel. Excess iron storage; The presence of iron-red soil in the area may also be due to rocky weather and incense. Growing iron reduces oxygen loss in summer and reduces ferns. Pheromones grow in the water column. Loss of groundwater iron can be caused by the dissolution of surface water.

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