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Nirmali Seed as a Natural Biosorbent; Evaluation of its Potential for Iron (II) Removal from Steel Plant Effluents and Sewage Disinfecting Capacity

By

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ABSTRACT
The idea of water clarification by natural coagulants is many centuries old. Natural coagulants like ***Moring oelifera, Mangifera indica and Prunusarmeniaca, Strychnospotatorum*** are used for the treatment of waste waters. Nirmali Seed is a natural coagulant material with polyelectrolytes. These polyelectrolytes are responsible for coagulation property of Nirmali seeds. In general, the studies rampant in the literature reported application of Nirmali seed powder as water extract or as powder with dose selection using jar test. The treatment in most of the cases is based upon coagulation and removal. But in this study it has been modified that the methodology to suit our objectives as wanted to test the potential of Nirmali seed as a solid bio-sorbent surface in solid solution equilibrium adsorption studies. The dose selection has been done keeping in mind the amount of polyelectrolyte released when the seed powder is left in solution. The property of physi-sorption aided with chemi-sorption with minimum dose has been given importance in the present study.
The chief goal of this study is to find out the feasibility of applications of Nirmali Seeds for both Iron (II) reduction as well as disinfecting agent for sewage samples.

Key Words: Natural Biosorbent, ***Strychnospotatorum***, Waste Water Treatment.

1. Introduction

Nature has given gifts to human on this mother earth. In particular the prominent are environment, air, water and land. The survival of living beings is

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impossible without these natural resources. Water is an elixir to life. The complete water sources on the Earth consist of 97% salt and 3% fresh waters.

The source of drinking water to man is ground water, rivers, subsurface water etc,. It is the prime responsibility of the Government and municipal authorities to provide treated drinking water to its public. In order to meet the water demand the Government should take steps such as proper maintenance of both Drinking Water & Sewage treatment plants all over India.

The discharge of untreated sewage is single most important cause for pollution of surface and ground water in India. While many of the chemical substances that are being regulated but there are still contaminants that are playing a key role in the water contamination [1]. High concentration of substances can have negative impacts on aquatic flora and fauna [2]. Sulphur dioxide, Ammonia, Synthetic fertilizers including Nitrites, Phosphates silt sedimentation (slash & burn) are some of the examples of contaminants due to anthropogenic activities.

Nirmali Seed is a natural coagulant material with polyelectrolytes. These poly electrolytes are responsible for the coagulation property of Nirmali seeds [3]. In general, the studies rampant in the literature reported application of Nirmali seed powder as water extract or as powder with dose selection using jar test. The treatment in most of the cases is based upon coagulation and removal. But in this study it has been modified that the methodology to suit our objectives as wanted to test the potential of Nirmali seed as a solid bio-sorbent surface in solid solution equilibrium adsorption studies. The dose selection has been done keeping in mind the amount of polyelectrolyte released when the seed powder is left in solution. The property of physi-sorption aided with chemi-sorption with minimum dose has been given importance in the present study.

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2. Material & Methods

Strychnospotatorum L (Nirmali) seeds were collected and dried at 40 ^{o}C for 2 days in hot air oven. Seeds were made into powder and sieved to give a fraction of 100 mesh screen and used as a bio - sorbent. All the chemicals used in the experiments were of analytical grade. Stock Fe (II) solution was prepared using Ferrous Ammonium Sulphate in double distilled water. Solutions of different concentrations were prepared by adequate dilution of the stock solution with distilled water. pH of the solutions was adjusted with appropriate acid. All the Glassware and polypropylene flasks used were washed with 10% (v/v) HNO3 and rinsed several times with deionized distilled water. Batch mode experiments were conducted at 28^{o}C temperature by equilibrating selected dose of adsorbent (20 mg) in 100 ml of Fe (II) solutions of desired concentration in 250 ml glass conical flasks. The flasks were left undisturbed for solid solution equilibrium bio-sorption process. The influence of pH and contact time was studied. The results of Optimization studies were applied to Solutions with varying Concentration of Fe (II) [4].

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dose selection using jar test. The treatment in most of the cases is based upon coagulation and removal. But we have modified the methodology to suit our objectives as wanted to test the potential of Nirmali seed as a solid bio-sorbent surface in solid solution equilibrium adsorption studies. The dose selection has been done keeping in mind the amount of polyelectrolyte released when the seed powder is left in solution. The property of physi-sorption aided with chemi-sorption with minimum dose has been given importance in the present study.

3. Results & Discussions

pH is one of the most important environmental factor which influences not only site dissociation but also the solution chemistry of the heavy metals: hydrolysis, complexation by organic and inorganic ligands, redox and precipitation reactions. They are strongly influenced by pH and on the other hand, powerfully affect the speciation and the bio-sorption availability of the heavy metal. In the present work, adsorption could not be carried out beyond pH 3 due to precipitation and increase in the turbidity of solution (Fig: 1). Therefore; the experiments were done at a pH 3 It was seen that adsorption increased continuously with decrease in acidity till it reached an almost constant value at pH 3. At pH 1, an uptake of Fe (II) was less, probably because of the H^+ ions competition with the metal ions for the exchange sites in the sorbent [6]. The maximum uptake of Fe (II) was obtained at pH 3.0 by seed powder

3.1 Steel plant effluent

Samples were collected at the outlet of steel plant. The biosorption of Iron (II) by Nirmali seed powder was carried out with a retention period of one hour which was based some preliminary tests on dosage and retention time. Physico-Chemical parameters like pH, Conductivity, Turbidity, COD and Sulphate were analysed before and after treatment with Nirmali seed powder. There was 24.4% decrease in the turbidity value, 24.4% for Sulphates and 30% for Iron. A very small change was observed in pH and Chemical Oxygen Demand with 6.8% and Conductivity with 12.24% after the addition of Nirmali seed to the test samples.

3.2 Sewage Treatment plant samples:

Sewage samples were collected from the STP and experiments on physic-chemical & biological parameters like pH, turbidity, TDS, BOD, Chlorides, Residual Chlorine & coliforms were performed. Samples have been tested with nirmali seed powder and in the inlet samples there is a good decrease in turbidity with 77%, 54% in mixed and no change was observed in the outlet sample. In mixed sample the TDS decreased with 66.6% and less reduction was observed in inlet and outlet with 25% & 50%.The chloride concentration was in the inlet with 28.5%, 7.14 in mixed and 8.82 in the outlet. No change was observed in the residual chlorine concentration after the addition of Nirmali seed to the test samples which was shown in the table No: 3.

In the present investigation, the inhibition of number of coliform and ***E.coli*** is in conformity with the earlier findings in which alum is in combination with seed powder

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of ***Strychnospotatorum*** was used at variable pH level for removal of coliforms and E.coli.

Nirmali seeds are therefore effective as primary coagulants but must be regarded as coagulant aids. The low dosages in which they are used as coagulants aids will probably be much higher for the treatment of natural waters with high turbidities. [6].

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Table: 1. Optimization of Dose of Nirmali seed powder for bio - sorption studies
Solution taken is standard 40NTU

S. No	Wt. of Nirmali seed powder	Turbidity value after 12 hrs	Turbidity value after 24 hrs
1	20mg	12.0	7.1
2	40mg	31.2	24.3
3	60mg	30.2	32.1
4	80mg	51.2	68.0
5	1g	61.0	98.1

Table: 2. Optimization of pH of Fe (II) solution for bio - sorption study using Nirmali seed powder

Sample taken-5ml

Time	pH-1	pH-3
After 1hr	0.275--- 75.8%	0.202--- 82.4%
After 3hrs	0.286---75%	0.183---84%
After 5hrs	0.972	0.162--- 85.8%

Table No. 3. : Treatment of Fe (II) solution with Nirmali seed powder
Time - 1hr, pH-3 ,Dose - 20mg powder.

S.No.	Concentration of Fe (II)	% of reduction
1	100ppm	90.0
2	200ppm	94.0
3	400ppm	96.25
4	500ppm	87.6
5	600ppm	88.66
6	800ppm	91.37
7	1000ppm	85.4

Table No. 4. : Change in the Physicochemical quality parameters of steel plant effluent treated with *Strychnospotatorum* seed as bio-sorbent

Parameter	Before addition	After addition	Percentage of reduction
pH(mol/L)	7.69	7.16	6.89%
Turbidity(NTU)	08.6	06.5	24.4%
Conductivity(mmohs)	1.96	1.72	12.24%
Sulphates(mg/l)	490mg/l	370mg/l	24.4%
Iron(mg/l)	0.01mg/l	0.007mg/l	30%
Chemical Oxygen Demand(C.O.D)(ppm)	60mg/l	56mg/l	6.6%

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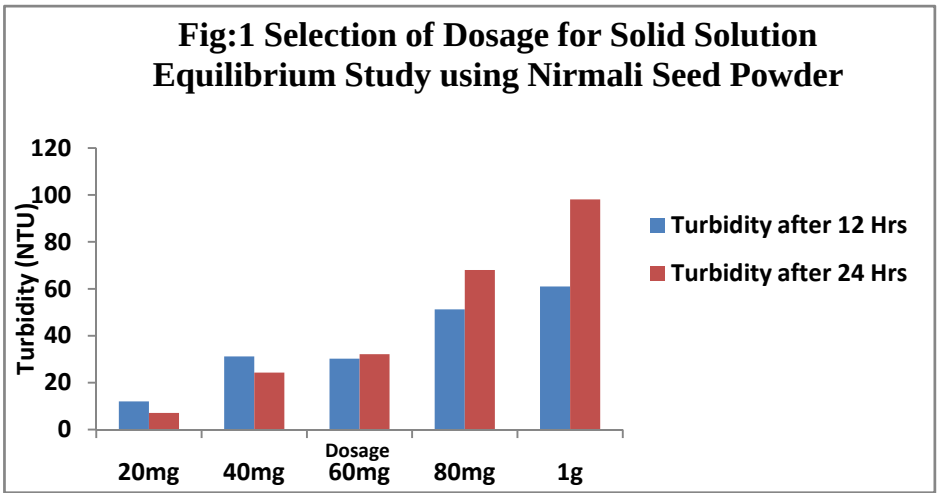
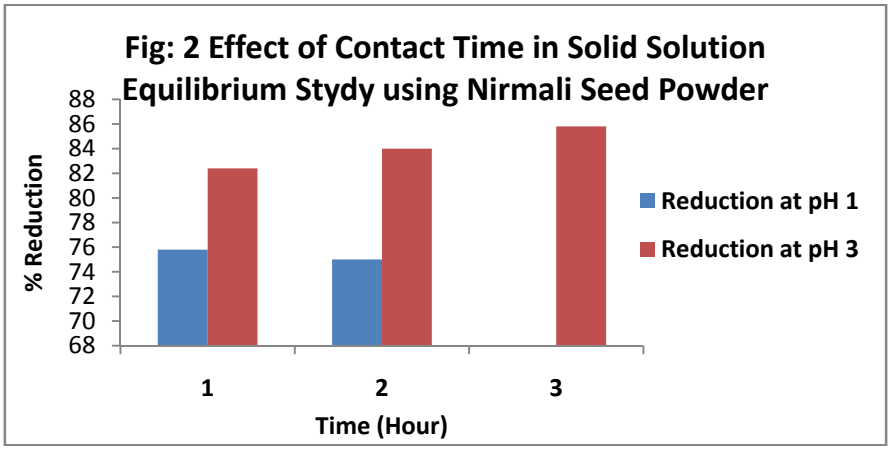
Table No. 5: Change in the Physicochemical quality parameters of sewage treated with *Strychnospotatorum* seed as bio-sorbent

Parameter	Inlet		reduction	Mixed		reduction	Outlet		reduction
	Before	After	(%)	Before	After	(%)	Before	After	(%)
pH	6.46	5.90	8.6%	8.8	6.96	20%	8.1	7.70	4.9%
Turbidity NTU	54.6	12.1	77%	5.0	02.3	54%	01.4	01.3	0.07 %
Total Dissolved Solids (TDS)	8000 mg/l	6000 mg/l	25%	3000 mg/l	1000 mg/l	66.6 %	2000 mg/l	1000 mg/l	50%
Biological Oxygen Demand—BOD	1379.80mg/l	1859.80 mg/l	-25.80 %	1349.80 mg/l	2099.80 mg/l	-33.34 %	83.8 mg/l	239 mg/l	-64.9%
Chlorides(mg/l)	104.99 mg/l	74.99 mg/l	28.5 %	279.99 mg/l	259.99 mg/l	7.14 %	169.99 mg/l	154.99 mg/l	8.82 %
Residual chlorine-ppm	NC	NC		NC	NC		0.1 ppm	0.1 ppm	NC
Coliforms	12.2×10^5	6.2×10^5	49.18 %	14.8×10^3	2.3×10^3	84.4 %	5.4×10^2	1.2×10^2	77.7 %

NC-no change





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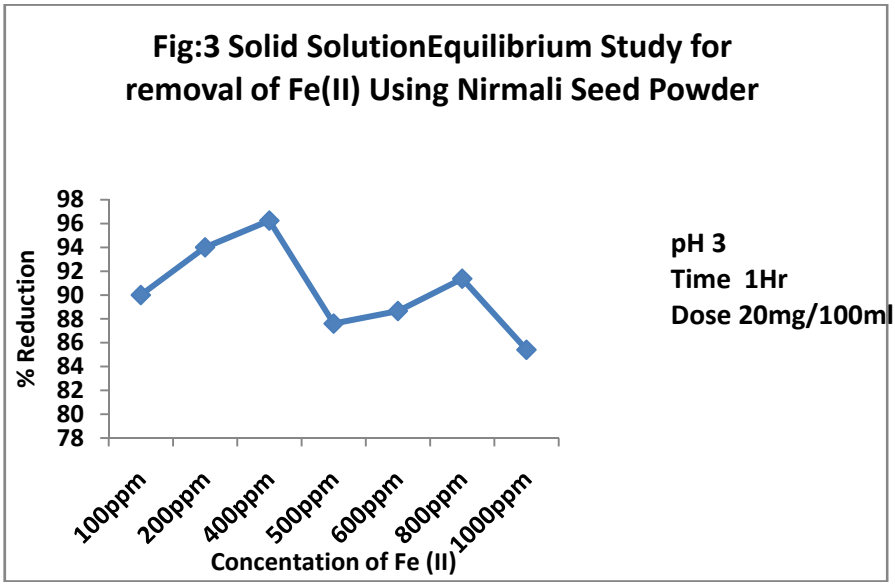
Fig:3 Solid SolutionEquilibrium Study for removal of Fe(II) Using Nirmali Seed Powder
% Reduction
98
96
94
92
90
88
86
84
82
80
78
100ppm
200ppm
400ppm
500ppm
600ppm
800ppm
1000ppm
Concentation of Fe (II)
pH 3
Time 1Hr
Dose 20mg/100ml