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Biosorption and Kinetics of Lead Using Tamarindus Indica

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Abstract:
Today heavy metals pollution is a big challenge. Many new technologies came into picture for recovery of metal ions. Among these, Biosorption is one. This research work reported the results using inexpensive biomaterial Tamarindus indica for the removal of lead. Effect of various parameters like time, dosage and initial concentration and kinetic studies were reported. The maximum removal of lead was found to be 82.1%. The optimum agitation time is 35 min and the optimum dosage is 1gm. The maximum removal of lead occurs at initial concentration of 20mg/l. The data suited to both Freundlich and Langmuir adsorption isotherms. This data is well fitted to Langmuir model, with correlation coefficient of 0.98. The kinetic data is better fitted to the pseudo second order model.

Keywords: Biosorption, heavy metals, Tamarindus indica, and adsorption isotherms

1.INTRODUCTION:

The presence of heavy metals in aquatic systems is known to cause severe damage to aquatic life, and these metals kill microorganisms during biological treatment of wastewater with a consequent delay of the process of water purification. Most of the heavy metals are soluble in water and form aqueous solutions and cannot be separated by ordinary physical separation. These heavy metals come from various industries like battery manufacturing and lead paint industry [1].

There are many physical and chemical waste water treatment processes like sedimentation, aeration; screening and adsorption are being used. Among these adsorption is a less expensive process; it converts one form of pollution to other. An eco friendly and economically available technology is much desirable in days to come. Biosorption method is one that easily and effectively removes heavy metals from waste water.

Heavy metals, even at low concentration are difficult to remove by ion exchange, chemical oxidation and other techniques. There is a need of for low cost, easily available and efficient technique for the removal of pollutants. Biosorption, has most economical method in present days for this case [2].

The basic principle of biosorption is that the natural degradation of contaminants by the micro organisms which are housed by the biomaterials. The biomaterial used is tamarind fruit shell, which has no disposal problem. Our present work mainly deals with the efficient usage of tamarindus indica for the removal of lead [3,4].

2. MATERIALS AND METHODS

2.1 Preparation of Tamarind fruit shell Biosorbent :

Tamarind fruit Shells were collected from the natural tamarind trees. The tamarind fruit shells are cleaned with distilled water, after that the biosorbent is dried in an oven at 60^0c for about 24 hours. The dried biomaterial was grounded and then sieved. After this 82.5 µm size particles are used for analysis, which are retained on 120 mesh size. Finally the tamarind fruit shell powder is stored in airtight plastic bottles for further use as biosorbent[5].

2.2 Preparation of stock solution

The lead metal stock solution was prepared by dissolving $Pb(NO3)_2$ in distil water. The test solution consisting of Pb(II) ions is prepared by dilution of 1.00 g/l stock solution. Solution P^H is adjusted with HCL or NaOH.

3. RESULTS AND DISCUSSION:

3.1. Agitation time:

Lead stock solution of 30ml is poured in a conical flask. One gram of 82.5 µm size biosorbent is added. The sample bottle is placed on to a shaker and is kept for 1 min. for adsorption. Similarly the same is followed to different samples at 2, 4, 8, 12, 15, 20, 25, 30, 35, 40, 45, 50 minutes for adsorption. After this samples are collected, filtered and then the readings are noted. From Table.a and Fig.1, it was observed that, with an increase in time, the % Removal of lead increased from 1-35 min. After this no change in percentage removal occurred. So the optimum agitation time is found at 35 minutes [7]. It is noticed that the rate of biosorption is faster in the initial stages because adequate surface area of the biosorbent is available for the adsorption of lead

3.2 .Effect of initial concentration:

30 ml of 5mg/l concentrated solution is taken in a conical flask. One gram of 82.5 µm size biosorbent is added, other concentrations like 20,25,30,35,40,45,50,55 and 60 mg/l are prepared. The bottles are placed on to a shaker for an optimal time period of 35 minutes. After biosorption, sample is filtered and then filtrate is collected separately. From Table.b and Fig.2, it was obsereved that Percentage Removal of lead decreases with increasing initial concentration. We can see at a concentration of 5mg/l lead stock solution the percentage removal is 82.1%[8]. Such behavior can be attributed to the increase in the amount of adsorbate to the unchanging number of available active sites on the biosorbent (since the amount of adsorbent is kept constant).

3.3. Effect of dosage:

30 ml of stock solution is taken in a conical flask. One gram of biosorbent is added. Then the sample is placed on

to a shaker and is allowed for biosorption. After this the solution is filtered and filtrate is collected separately [9, 10]. Then the filtrate is analysed. From Table.c and Fig.3, it was observed that the percentage removal is increased with increasing dosage. Such behavior is obvious because the number of active sites available for metal removal would be more as amount of the biosorbent increases

Table .a) Percentage Removal of lead with Agitation time

S.No.	Agitation time,t, min	% Removal of lead
1	1	25
2	2	35
3	4	46
4	8	58
5	12	64.5
6	15	67.5
7	20	70
8	25	77.5
9	30	78.5
10	35	82.1
11	40	82.1
12	45	82.1
13	50	82.1

Table .b) Percentage Removal of lead with Initial concentration

S.No.	Initial metal ion Concentration,C_0, mg/l	%removal of lead
1	5	81.8
2	10	76.6
3	15	74
4	20	71.6
5	25	62.2
6	30	60.3
7	40	55
8	50	52
9	60	46.6

Table .c) Percentage removal vs biosorbent Dosage

S.No.	Biosorbent Dosage, (w) gm	%Removal of lead
1	0.1	67.8
2	0.2	68.7
3	0.3	70.9
4	0.4	72.5
5	0.5	74.5
6	0.6	76.6
7	0.7	78.3
8	0.8	79.1
9	0.9	81.2
10	1.0	82.2
11	1.1	82.2

Table .d) Generations of data for freundlich isotherm

S.No.	Initial Concentrationof lead,C_0, mg/l	$q_e = (C_0-C_e)/m$,mg/gm	log C_e	log q_e
1	5	0.1047	0.1789	-0.9800
2	10	0.198	0.5314	-0.7033
3	20	0.3405	0.9370	-0.4678
4	30	0.45	1.176	-0.3467
5	40	0.54	1.3424	-0.2676
6	50	0.66	1.4624	-0.2006
7	60	0.6901	1.5682	-0.1611
8	80	0.8701	1.7076	-0.0604
9	100	0.9600	1.8325	-0.017

Table .e) Generations of data for Langmuir isotherm

S.No.	Initial Concentration of lead,C_0, mg/l	$q_e = (C_0-C_e)/m$, mg/gm	C_e/q_e
1	5	0.1047	14.4242
2	10	0.198	17.17172
3	20	0.3405	25.40382
4	30	0.465	31.8279
5	40	0.54	40.74074
6	50	0.66	42.42424
7	60	0.6901	53.61542
8	80	0.8701	58.61395
9	100	0.9600	70.83333

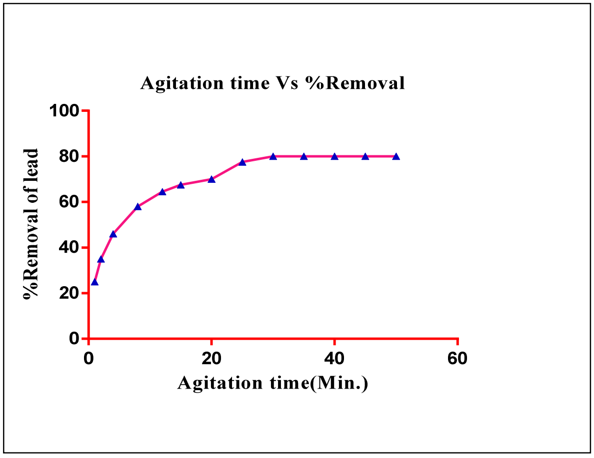

Fig .1 Variations in %Removal with Agitation time

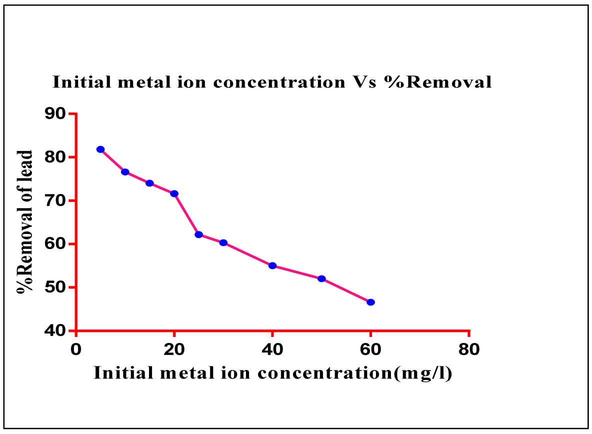

Fig .2 Variations in %Removal with Initial concentration

4. KINETIC STUDIES:

4.1. Freundlich Isotherm:

The kinetics study was investigated using Freundlich and Langmuir isotherms.

Freundlich eqution is given by $Qe = K_f*C_e^n$

In logarithmic form $Log\ Q_e = LogK_f + nLogC_e$

Here Q_e represents the equilibrium metal uptake; C_e represents the concentration of adsorbate.

n gives the adsorption intensity and K_f is distribution coefficient. See Table.d) and Fig.4

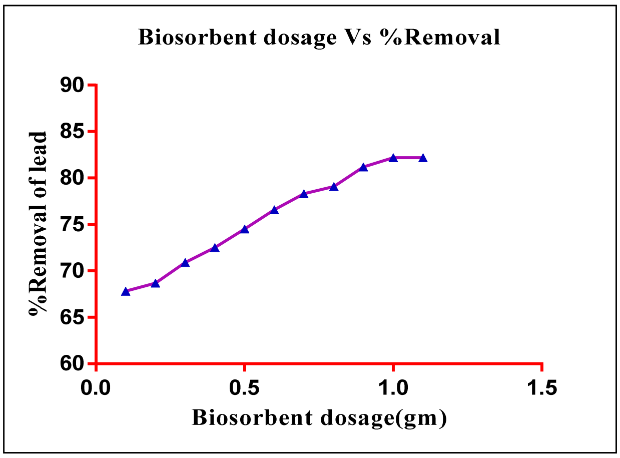

Fig . 3. Variations in %Removal with Initial Dosage

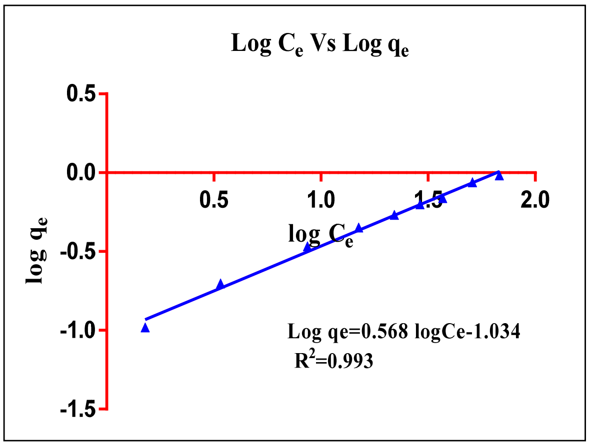

Fig .4. Freundlich isotherm

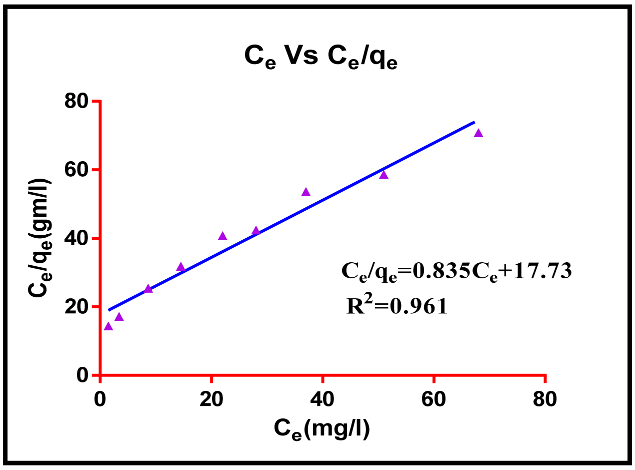

Fig.5 Langmuir isotherm

4.2. Langmuir Isotherm:

The Langmuir isotherm equation is given by $C_e/Q_e = C_e/Q_m + 1/(Q_m*b)$

Where Qm, b are constants. Q_m is maximum amount of metals adsorbed [11].

See Table.e) and Fig.5

5. CONCLUSIONS:

- The percentage removal of lead is increased with increasing agitation time.
- The percentage removal of lead is reduced with increase in initial metal ion concentration.
- With increase in biosorbent dosage, increased in the percentage removal of lead metal.
- The kinetic data is well suited to pseudo second order model for the biosorbent of Tamarind fruit shell.
- Based on above we can conclude that Tamarind fruit shell is preferable for the biosorption of lead.
- The optimal agitation time is 35 minutes and % Removal is 82.1
- The maximum percentage removal of lead occurred at 5mg/l.
- The optimum dosage is 1gm and %Removal is around 82.5.
- R^2=0.993 for Freundlich isotherm

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