Studies on Heavy Metal Exile through Natural Products Immobility in Water

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Abstract: ***The disposal of metal rich effluents poses various hazardous problems even to industries despite of its size or location. Owing to their high cost and huge energy consumption various heavy metal removal methods are not used now a day's that's why various low cost methods are been developed and used now a day's. In this paper we study the attempt to remove various metals aka Cadmium, Arsenic and Nickel from waste water using low cost materials like Multani clay, powdered form of Tamarind seeds, Drumsticks, Gall Oak, and Betel Nuts. Various observations study depicts that all these natural materials are able to remove the targeted heavy metals effectively and the observation leads us to low PPM (25 to 35) of heavy metals in water as compared to high raw water. The observation of Cadmium was most by Multani clay as compared to other natural treatments done by us. For Nickel Tamarind seeds were most effective. The pH, Conductivity and temperature play an important role is absorption of these heavy metals. These processes can be used in large scale industries too and can be an effective game changer in field of water treatment.***

Keywords: Heavy metals, water, disposal, rich effluents, industries, energy consumption, Cadmium, Nickel, Arsenic, Imli (Tamarind seeds), Surjana (Drum Sticks), Manju Phal (Gall Oak), Supari (Betel Nut), Multani Mitti, pH, temperature, conductivity etc.

1. Introduction

The environment management consist of system having physical, chemical, biological, social, cultural and economic elements which are all interlinked to each other. Due to the complex nature of the human beings, the composition of the environment change. This change alters growth of citied, industrialization, mining, agriculture etc. these activities are very essential for human development, but leads to various objectionable products leaked to the environment which is miserable for living organisms.

The contamination of aquatic environment is one of the basic pollution that will be there for lifetime i. e. its worst for future. Water is needful for life because of its recreational properties as food, cleanser, dilute, coolant, power, transporter, container, disposer etc. this discriminate disposal of water by different sources from waste causes the pollution problem. We have seen the industrialization and deterioration of water sources after it. As pollution increases the use of goods and water increases which in turn increases the complexity of the waste. Increasing the contamination of aquatic resources with various pollutants including toxic metals and heavy metals is not only endangering the aquatic biota of the area but also creating a worldwide problem of shortage of drinking water.

Out of the 118 elements we discovered till date very less are toxic some are Cadmium, Arsenic, Chromium, Plutonium, Cesium, Fluorine, Lead, Mercury, Beryllium and Polonium. These causes concerns in minds of public and us engineers to find out an economical, easily viable strategy for the restoration of abused ecosystems by heavy metal toxicity. To solve this heavy metal recovery from waste water is a good option these can be done by absorption, adsorption, precipitation, hydroxyl, carbonate, sulfide, oxidation, reduction etc. technology. Now days the traditional methods are not that useful so advance technologies and combination of old technologies are used to break the Organic/Inorganic legends present.

2. Objectives of this Study

Keeping in view the above all factors we attempt to explore the potential of few biomaterials which can absorb the heavy metals from liquid medium. These materials are powdered seeds of various natural materials posted in table 01. The heavy metals we are estimating are Nickel, Cadmium and Arsenic.

3. Material and Methods

Table 1: Natural materials taken and their part

S. No.	Name	Form	Part Used
1	Tamarind (इमली)	Powder	Seeds of Tamarind
2	Drum Sticks (सुरजना)	Powder	Drum Sticks
3	Betel Nuts (सुपारी)	Powder	Betel Nuts
4	Gall Oak (मांझू फल)	Powder	Seeds of Gall Oak
5	Soil (मुल्तानी मिटटी)	Fine Filtered	Multani Clay

4. Setup

The materials were powdered taken 1 gram each in a 50 ml conical flask. To it added 25 ml of heavy metal solution with concentration from 100 to 25µg/ml was added. The content i. e. the conical flask is than shaken thoroughly for 30 mins in a mechanical shaker. Three replicates of each set were taken and a control set is also taken for reference. The shaken flask content was then allowed to settle for another 30 mins and the pH, conductivity were been measured by digital meters. Than it was filtered by waterman filter (number 42) and the respective heavy metal contents were estimated using Atomic Absorption Spectrophotometer.

The metals were analyzed by using AAS at a wavelength and Slit width given in manuals of Perkin Elmer AAS which are –

Table 2: Element their wavelength and settings of AAS

Elements	Wavelength in nm	Slit Width	Flame Gas
Nickel (Ni)	232.0	0.2	A - Ac
Cadmium (Cd)	228.8	0.7	A - Ac
Arsenic (As)	193.7	0.5	A - Ac

The testing can contain some process errors and human errors so to test the existing significance between the means of treatment and response of the test species we applied the Student's t - test and any value less than 5% was been rejected.

5. Results

Table 3: Change in **pH** for different concentrations of **Arsenic** with standard deviation

Materials	100 PPM	SD in ±	75 PPM	SD in ±	50 PPM	SD in ±	25 PPM	SD in ±
Control	5.68	0.11	6.17	0.18	6.12	0.08	5.92	0.06
Multan Clay	6.42	0.10	6.78	0.19	7.00	0.13	7.08	0.06
Betel Nut Powder	4.54	0.10	4.61	0.10	4.70	0.09	4.74	0.09
Drum Stick Powder	4.99	0.06	5.05	0.11	5.12	0.12	5.15	0.06
Gall Oak Powder	4.03	0.06	4.09	0.05	5.90	0.11	5.91	0.10
Tamarind Seeds Powder	5.62	0.11	5.68	0.13	5.98	0.12	5.96	0.11

Table 4: Change in **pH** for different concentrations of **Nickel** with standard deviation

Materials	100 PPM	SD in ±	75 PPM	SD in ±	50 PPM	SD in ±	25 PPM	SD in ±
Control	6.16	0.04	6.42	0.06	6.08	0.12	5.01	0.09
Multan Clay	7.23	0.06	7.31	0.03	7.22	0.11	7.26	0.05
Betel Nut Powder	4.56	0.03	4.59	0.11	4.63	0.04	4.65	0.04
Drum Stick Powder	4.87	0.08	4.91	0.10	4.98	0.08	4.99	0.06
Gall Oak Powder	3.87	0.04	3.87	0.07	3.87	0.04	3.90	0.07
Tamarind Seeds Powder	5.69	0.07	5.71	0.08	5.79	0.12	5.80	0.04

Table 5: Change in **pH** for different concentrations of **Cadmium** with standard deviation

Materials	100 PPM	SD in ±	75 PPM	SD in ±	50 PPM	SD in ±	25 PPM	SD in ±
Control	5.27	0.09	5.48	0.14	5.40	0.12	5.47	0.10
Multan Clay	5.76	0.10	5.97	0.12	6.30	0.10	6.90	0.13
Betel Nut Powder	4.05	0.06	4.25	0.10	4.36	0.09	4.50	0.17
Drum Stick Powder	4.70	0.08	4.85	0.11	4.79	0.06	4.85	0.08
Gall Oak Powder	3.78	0.06	3.78	0.12	3.72	0.08	3.82	0.12
Tamarind Seeds Powder	5.27	0.10	5.34	0.13	5.38	0.07	6.67	0.11

Table 6: Change in **Conductivity (μ Mho)** for different concentrations of **Arsenic** with standard deviation

Materials	100 PPM	SD in ±	75 PPM	SD in ±	50 PPM	SD in ±	25 PPM	SD in ±
Control	0.41	0.01	0.33	0.06	0.23	0.05	0.13	0.01
Multan Clay	1.25	0.05	1.09	0.10	1.03	0.02	1.11	0.06
Betel Nut Powder	1.04	0.02	1.03	0.06	0.94	0.08	1.01	0.04
Drum Stick Powder	2.30	0.08	2.18	0.05	1.91	0.01	2.14	0.06
Gall Oak Powder	1.30	0.02	0.94	0.04	0.86	0.06	0.89	0.05
Tamarind Seeds Powder	0.95	0.01	0.85	0.03	0.73	0.05	0.68	0.04

Table 7: Change in **Conductivity (μ Mho)** for different concentrations of **Nickel** with standard deviation

Materials	100 PPM	SD in ±	75 PPM	SD in ±	50 PPM	SD in ±	25 PPM	SD in ±
Control	0.27	0.05	0.20	0.05	0.13	0.06	0.08	0.02
Multan Clay	1.10	0.06	1.04	0.04	1.07	0.04	0.96	0.03
Betel Nut Powder	0.93	0.02	0.93	0.06	0.84	0.09	0.91	0.02
Drum Stick Powder	2.15	0.06	2.25	0.08	2.05	0.06	2.20	0.09
Gall Oak Powder	0.91	0.08	0.87	0.02	0.82	0.10	0.75	0.03
Tamarind Seeds Powder	0.67	0.05	0.62	0.04	0.60	0.02	0.60	0.02

Table 8: Change in **Conductivity (μ Mho)** for different concentrations of **Cadmium** with standard deviation

Materials	100 PPM	SD in ±	75 PPM	SD in ±	50 PPM	SD in ±	25 PPM	SD in ±
Control	0.34	0.01	0.30	0.03	0.22	0.06	0.09	0.02
Multan Clay	1.41	0.06	1.30	0.10	1.05	0.04	0.99	0.05
Betel Nut Powder	1.21	0.09	1.07	0.11	0.87	0.33	0.98	0.06
Drum Stick Powder	2.90	0.12	2.55	0.18	2.15	0.12	2035	0.12
Gall Oak Powder	1.07	0.06	0.99	0.06	0.86	0.05	0.75	0.04
Tamarind Seeds Powder	1.03	0.05	0.85	0.07	0.66	0.04	0.60	0.03

Table 9: Change in **Metal content** for various Bio - absorbers in **Nickel** solution at different concentrations with standard deviation

Materials	100 PPM	SD in ±	75 PPM	SD in ±	50 PPM	SD in ±	25 PPM	SD in ±
Multan Clay	79.16	9.64	68.56	8.23	47.13	6.11	23.45	5.56
Betel Nut Powder	82.16	6.35	68.94	5.63	43.77	7.36	19.76	6.39
Drum Stick Powder	78.71	6.70	54.31	8.32	38.61	9.32	25.30	6.45
Gall Oak Powder	85.73	9.64	61.31	4.68	43.88	9.26	23.11	8.31
Tamarind Seeds Powder	84.92	6.45	69.43	9.31	44.68	9.13	22.50	9.64

Table 10: Change in **Metal content** for various Bio - absorbers in **Cadmium** solution at different concentrations with standard deviation

Materials	100 PPM	SD in ±	75 PPM	SD in ±	50 PPM	SD in ±	25 PPM	SD in ±
Multan Clay	91.47	8.56	73.98	6.35	50.00	0.96	24.96	6.94
Betel Nut Powder	90.68	7.69	68.68	9.65	48.52	6.87	24.63	9.68
Drum Stick Powder	93.56	9.65	66.58	9.31	45.15	6.31	21.38	8.36
Gall Oak Powder	93.65	8.63	70.52	9.25	44.36	9.35	23.46	7.31
Tamarind Seeds Powder	92.44	8.37	69.01	6.85	44.11	8.39	23.60	6.45

Table 11: Change in **Metal content** for various Bio - absorbers in **Arsenic** solution at different concentrations with standard deviation

Materials	100 PPM	SD in ±	75 PPM	SD in ±	50 PPM	SD in ±	25 PPM	SD in ±
Multan Clay	94.53	5.09	73.91	9.19	49.50	6.13	25.00	7.15
Betel Nut Powder	93.16	4.25	68.78	7.10	47.41	6.19	25.00	9.29
Drum Stick Powder	94.96	6.39	70.36	9.51	46.25	8.42	24.96	7.63
Gall Oak Powder	93.56	5.36	69.58	9.35	44.38	6.60	23.59	4.70
Tamarind Seeds Powder	94.45	9.70	72.50	6.90	48.85	6.90	23.64	9.34

6. Dialogue

The disposal of heavy metal rich effluents can be said as sewage pose a eye opening problem to every small and large scale industries of any small town or big city. Owing to heavy energy consumption cost and various chemicals and physical technologies used, the heavy metal removal is not easy but these days we are moving swiftly towards the low cost technologies. These technologies are eco - friendly too and the combinations we are using are having a high efficiency cleaning of sewage.

In the present study we attempt to remove different heavy metals i.e. Nickel, Cadmium and Arsenic, by natural products available which are Tamarind seeds (इमली), Drum Sticks (सुरजना), Betel Nuts (सुपारी), Gall Oak (मांझू फल) and Soil (मुल्तानी मिटटी). These materials were evaluated for their adsorption potential with different concentrations of the three metals selected.

The observations we studied are that all five are able to absorb heavy metals from water medium. The removal at lower concentrations (25 - 50 PPM) is the most as compared to the removal at higher concentrations (75 - 100 PPM). Adsorptions potential of Multani Clay was the most for Cadmium and Arsenic as compared to other natural products taken. For Nickel, Tamarind seeds were most effective for low concentration purification while in high concentration Multani Clay was the best. The trend of heavy metal removal is as follows –

Heavy Metal – Nickel
For concentration (25 to 50 PPM) –
Multani Clay > Gall Oak > Tamarind seeds > Betel Nuts > Drumsticks
For concentration (75 to 100 PPM) –
Tamarind seeds > Betel Nuts > Gall Oak > Multani Clay > Drumsticks

Heavy Metal – Cadmium
For concentration (25 to 50 PPM) –
Multani Clay > Betel Nuts > Tamarind seeds > Gall Oak > Drumsticks
For concentration (75 to 100 PPM) –
Multani Clay > Gall Oak > Tamarind seeds > Betel Nuts > Drumsticks

Heavy Metal – Arsenic
For concentration (25 to 50 PPM) –
Multani Clay > Betel Nuts > Tamarind seeds > Drumsticks > Gall Oak
For concentration (75 to 100 PPM) –
Multani Clay > Drumsticks > Tamarind seeds > Gall Oak > Betel Nuts

The pH, conductivity, climatic conditions, insecticides, pesticides and temperature play an important role in adsorption process but these factors need another study which can be done in future.

7. Conclusion

The recovery of materials is possible but further various parameters are left behind which can be done in near future. The natural ingredients used in water purification have a good potential, so an attempt can be applied at small scale industries for water treatment. The efficiency is not at par still the low cost of purifiers will attract all towards it, as it's a chemical free method, eco - friendly and can be disposed off easily. The residual material after biosorption is proved to be a good fertilizer too and so can be packed and sold in market for extra money.

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