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Reduction of Heavy Metals using Moringa Oleifera Leaf and Bark Extract from Various Lakes in Vellore

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Abstract: **The present study document about the physicochemical and heavy metal analysis from contaminated water in and around Vellore city, Thandalam Lake, thirumalai lake, sadhuperi lake, minnur lake, periyeri lake. Due to industrial action environment get polluted on many faces. It contaminates many sources of drinking water, releases unwanted toxins into the air and reduces the quality of soil all over the world.Water pollution and soil pollution are often caused directly due to inefficiency in disposal of waste. Long term exposure to polluted air and water causes chronic health problems, making the issue of industrial pollution into a severe one. It also lowers the air quality in surrounding areas which causes many respiratory disorders. Moringa olifera, also known as drumstick fast growing, drought-resistance tree and majorly cultivated in southern areas. Also, it used for water purification. Contaminated water samples were treated by the modified moringa olifera leaf and moringa olifera bark powders. Reduction in heavy metals observed by atomic absorption spectroscopy. Physicochemical parameters like pH, Turbidity, BOD, COD, Nitrate fall out of the permissible range with reference of BIS, Drinking standards. Hence, suggested to take proper care to avoid contamination of water pollution through periodic monitoring of the water quality.**

Keywords**: pollution, adsorption, metal removal, moringa oleifera**

I. INTRODUCTION

Heavy metals are naturally occurring elements that have a high atomic weight and a density at least 5 times greater than that of water. Chromium, arsenic, cadmium, mercury, and lead have the greatest potential to cause harm on account of their extensive use, the toxicity of some of their combined or elemental forms, and their widespread distribution in the environment. Hexavalent chromium, for example, is highly toxic as are mercury vapour and many mercury compound.

Their multiple industrial, domestic, agricultural, medical and technological applications have led to their wide distribution in the environment raising concerns over their potential effects on human health and the environment. Their toxicity depends on several factors including the dose, route of exposure, and chemical species, as well as the age, gender, genetics, and nutritional status of exposed individuals.

Lead has many different industrial, agricultural and domestic applications. It is currently used in the production of lead-acid batteries, ammunitions, metal products (solder and pipes), and devices to shield X-rays. The nervous system is the most vulnerable target of lead poisoning. Headache, poor attention spam, irritability, loss of memory and dullness are the early symptoms of the effects of lead exposure on the central nervous system. Arsenic is a existing element that is detected at low concentrations in virtually all environmental matrices. Contamination with high levels of arsenic is of concern because arsenic can cause a number of human health effects. Several epidemiological studies have reported a strong association between arsenic exposure and increased risks of both carcinogenic and systemic health effects. Mercury is a heavy metal belonging to the transition element series of the periodic table. It is unique in that it exists or is found in nature in three forms (elemental, inorganic, and organic), with each having its own profile of toxicity Humans are exposed to all forms of mercury through accidents, environmental pollution, food contamination, dental care, preventive medical practices, industrial and agricultural operations, and occupational operations. Chromium (Cr) is a naturally occurring element present in the earth's crust, with oxidation states (or valence states) ranging from chromium (II) to chromium (VI) Chromium concentrations range between 1 and 3000 mg/kg in soil, 5 to 800 µg/L in sea water, and 26 µg/L to 5.2 mg/L in rivers and lakes.

II. BISORPTION OF HEAVY METALS USING MORINGA OLEIFERA

In this study Moringa olifera leaves (biosorbent) is used for Cadmium (II) removal from water as a natural alternative for synthetic sorbents. Synthetic water was used to find optimum conditions for water treatment using biosorbent. The effect of biosorbent dosage and particle size, contact time, and pH effect were studied. Atomic Absorption Spectroscopy (AAS) was used to monitor the Cd (II) concentration before and after treatment with biosorbent.

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The use of *M. oleifera* for water purification is part of African indigenous knowledge (Sajidu *et al.*, 2006).

Moringa was first studied and confirmed for its coagulant property by Jahn (1981), after observing women in Sudan use the seeds to clarify the turbid Nile water. The seeds act as a flocculent that attract and aggregate suspended particles in water, these particles then precipitate out of the water as flakes, leaving clearer water.

The purification and clarification potentials of *M. oleifera* seed is not limited to removal of suspended organic and biological agents only, the seed powder have been reported to have adsorption properties for heavy metals. A study by Veronica *et al*. (2012) reveals that *M. oleifera* seed biomass performed well in biosorption of lead (Pb), copper (Cu), cadmium (Cd), nickel (Ni), manganese (Mn) and zinc (Zn). The study also reveals that the biosorption capacity was neither affected by pH in a range of 3.5-8.0 nor the presence of other metal ions in a multi-metal solution.

Moringa oleifera (drumstick), is a drought tolerant, cosmopolitan tropical, tree, available throughout the year, it has various pharmacological uses, viz. analgesic, antihypertensive and anti-inflammatory effects. The powdered seed of the plant *Moringa oleifera* has coagulating properties that have been used for various aspects of water treatment such as turbidity, alkalinity, total dissolved solids and hardness. However, its biosorption behaviour for the removal of toxic metals from water bodies has not been given adequate attention (Kumari *et al*., 2005). The biosorption efficiency of *Moringa oleifera* seeds for Pb^{2+} and Cr^{2+} from wastewaters was investigated by measuring the efficiency of the metal removal from artificial wastewater by varying contact time, pH, particle size, adsorbent dosage, effect of pretreatment in a batch-process series of experiments.

III. Materials And Methods

Sampling area

Heavy metal polluted lakes were identified from lake bodies in and around Vellore, and also various other studies on 2014 on Thandalam Lake (pratheeba et al, 2014) and (k.Ambiga and Dr. R.Annadurai 2013). Water sampling was done according to the procedure mentioned for heavy metal analysis and estimation of BOD and COD and coliform reduction in contaminated waters.

FIG 1: SAMPLE AREA

Moringa oleifera leaf and bark biomass

Citric Acid modified Moringa oleifera leaf and bark (CAMOL and CAMOB) were conglomerated, taking sundried leaf and bark samples and the leaves and bark. The biomass was then dried overnight at 50^0C and called CAMOL and CAMOB was stored in an airtight plastic cover in refrigerator which was used for further tests.

Atomic absorption spectrophotometer

Soil samples were acidified in the field with concentrated HNO_3 (5 mL/L of water sample to reduce the pH of the sample, pH > 2.0) for the total metal estimation. Total metal content in soil was determined by digesting 0.5 g of soil/ sediment sample from each site with a mixture of Conc HNO_3 and $HClO_4$ (10 mL + 2 mL). The digested samples were filtered through Whatman filter No. 42 and finally volumes were made 10 mL with 0.1 N HNO_3 and analyzed for heavy metals using Atomic Absorption Spectrophotometer (Bharti et al., 2013)

Optimization of biosorption parameters and biosorption

For the optimum pH value the parameters required for the uptake of metals were determined using 50 mg L concentration of metals. The effect of biosorbent dosage and particle size, contact time, and pH effect were studied. The batch studies were performed using 10-1000 mg/L metal ion concentrations, pH 2.0 to 9.0, biosorbent dosage from 0.010-0.140 g and temperatures 293- 313 K and contact time of 0-100 mins. The solutions were filtered using Whatman filter paper 41.

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After optimization of the parameters, further biosorption from polluted water samples was done using AAS after the separation of the biosorbent. The extent of biosorption was calculated using the formula.

$$\text{Biosorption } \% = \frac{(C_i - C_f)}{C_f} \times 100$$

C_i = initial concentration mg/l

C_f = final concentration mg/l

IV. Result And Discussion

Chemical modification of biosorbent was carried out to increase the biosorption efficiency using low cost citric acid. The chemically modified bark and leaf were dried and powdered. Chemical modification increased the surface area and thereby the adsorption ability of both the leaf and bark. These biosorbents were used to treat the raw water samples. Colour of the samples changed from brown to off white and there was a decrease in turbidity and odour.

Fig.3: Polluted Lake Water Before Treatment

Fig 4: Polluted Lake Water After Treatment

Optimization of Biosorption parameters:

Initially optimal biosorption was found at metal concentrations of 10-50 ppm for Ni, Cr, Pb and solutions. The biosorption decreased with increasing metal concentrations. Optimal pH was found to be 5 for all the metal ions for CAMOL and CAMOB. This was found to be coinciding with the characterization results of [3] . The optimal biomass concentration for leaf and bark was found to be 0.04 gms beyond which at higher biomass concentrations, there was no increase in biosorption. The ideal contact time was found to be 50-60 mins for most of the metal ions. For all the metal ions it is observed that 50 min is enough to reach biosorption equilibrium. As contact time increases, metal uptakes increase initially, and then become almost stable, denoting attainment of equilibrium.

Effect of biosorbent on heavy metals

The below table shows that the value of metals in the sample and reduction value of metals after treatment

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TABLE 1
AAS RESULT

Sample	Pb	Ni	Ar
Permissible limit	0.01	0.02	0.05
Thandalam lake(U.T)	0.008	0.009	0.010
Thirumalai lake(U.T)	0.009	0.009	0.010
Minnur lake(U.T)	0.019	0.019	0.019
Periyaeri(U.T)	0.019	0.010	0.010
Sadhuperi(U.T)	0.013	0.010	0.007
Thandalamlake(B.T)	0.007	0.009	0.009
Thirumalailake(B.T)	0.009	0.009	0.008
Minnur lake(B.T)	0.009	0.010	0.009
Periyaeri(B.T)	0.009	0.009	0.009
Sadhuperi(B.T)	0.007	0.008	0.008
Thandalam lake(L.E)	0.008	0.005	0.008
Thirumalai lake(L.E)	0.008	0.004	0.006
Minnur lake(L.E)	0.006	0.007	0.007
Periyaeri(L.E)	0.003	0.009	0.006
Sadhuperi(L.E)	0.005	0.009	0.009

TABLE 2
AAS RESULT

Sample	Cu	Cr	Hg
Permissible limit	1.00	0.05	0.002
Thandalam lake(U.T)	0.007	0.009	0.008
Thirumalai lake(U.T)	0.008	0.010	0.010
Minnur lake(U.T)	0.017	0.020	0.019
Periyaeri(U.T)	0.021	0.013	0.009
Sadhuperi(U.T)	0.016	0.019	0.023
Thandalamlake(B.T)	0.006	0.008	0.009
Thirumalailake(B.T)	0.007	0.009	0.008
Minnur lake(B.T)	0.008	0.009	0.009
Periyaeri(B.T)	0.008	0.010	0.009
Sadhuperi(B.T)	0.006	0.007	0.008
Thandalam lake(L.E)	0.006	0.008	0.008
Thirumalai lake(L.E)	0.006	0.005	0.009
Minnur lake(L.E)	0.013	0.007	0.006
Periyaeri(L.E)	0.009	0.009	0.008
Sadhuperi(L.E)	0.007	0.009	0.008

Pb – lead Ni- nickel Ar – arsenic
Cu – copper Cr – chromium Hg - mercury

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From the above table it shows that the metal values of water sample are below in the permissible limit. Metal values are below in their atomic number and in their atomic value. Also, after the treatment of CAMOL and CAMOB the water sample will get reduced in their metal values.

In the observation of above value, arsenic and mercury has higher value when compared to other metals. But it act in the below permissible limit.

Effect of bisorbent on physicochemical parameters The below table value shows that the physicochemical parameter of water sample before and after treatment

TABLE 3
PHYSICOCHEMICAL PARAMETERS: DETECTION FOR PH

Location	U.S	L.E	%d ecre ase L.E	B.E	%d ecre ase B.T
Thandala m lake	5.97	5.28	12	4.10	32
Thirumal ai lake	10.68	8.2	23	7.8	27
Minnur lake	9.86	7.4	25	7.3	25
Periyeri lake	10.98	7.78	30	7.62	31
Sadhuper i lake	8.8	5.92	33	6.6	25

TABLE 4
PHYSICOCHEMICAL PARAMETERS: TURBIDITY

Locatio n	U.S	L.E	%d ecre ase L.E	B.E	%d ecre ase B.T
Thanda lam lake	6	3.4	44	3.2	47
Thirum alai lake	4.2	4	5	3.8	10
Minnur lake	3	2	33	2.1	30
Periyeri lake	4.5	4.1	10	3.8	16
Sadhup eri lake	3	2.5	17	2	34

U.S-Untreatedsample L.E-Leafextract B.E-Barkextract

TABLE 5
PHYSICOCHEMICAL PARAMETERS: NITRATE

Location	U.S	L.E	%d ecre ase L.E	B.E	%d ecre ase B.T
Thandalam lake	46	36	36	34	26
Thirumalai lake	32	20	20	12	63
Minnur lake	25	20	20	10	60
Periyeri	5.25	3	3	2.57	51
Sadhuperi	20	16	16	10	50

TABLE 6
PHYSICOCHEMICAL PARAMETERS: BOD

Location	U.S	L.E	%d ecre ase L.E	B.E	%d ecre ase B.T
Thandalam lake	400	120	70	98	76
Thirumalai lake	250	155	38	63	75
Minnur lake	180	137	24	62	66
Periyeri	100	38	62	48	52
Sadhuperi	25	13	48	10	60

TABLE 7
PHYSICOCHEMICAL PARAMETERS: COD

Location	U.S	L.E	%d ecre ase L.E	B.E	%d ecre ase B.T
Thandala m lake	800	287	64	253	68
Thirumala i lake	890	253	72	152	83
Minnur lake	384	136	65	94	76
Periyeri	125	98	22	65	48
Sadhuperi	390	153	61	67	83

From the above tables, the physicochemical parameters such as pH, turbidity, nitrate, BOD, COD were observed. It shows that the samples are above the permissible limit in the raw water. For example, the thanadalam lake has higher in the limit of all parameters. But after the treatment of CAMOL and CAMOB the ranges get reduced to some percentage.

V. CONCLUSION

Moringa oleifera bark and leaf can be used as an sorbent for reduction of metal ion and physicochemical parameters from polluted lake water.

It can be observed that 20 to 85% reduction of physicochemical parameter. From the biosorption and desorption processes, another advantage is the reuse of the biosorbent. Bark has excellent adsorption capacity. In overall moringa oleifera economical, efficient and eco-friendly.

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