REMOVAL OF LEAD FROM TEXTILE EFFLUENT USING CITRUS AURANTIUM PEEL ADSORBENT AND ALOE BARBADENSIS GEL ADSORBENT

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Abstract - *Heavy metals are major toxic pollutants present in dyeing, paper and Paint industrial effluent and would cause severe health effects on humans. They are released into the environment from textile industries. Cadmium, lead, zinc, chromium and copper are the most toxic metals of widespread use in textile industries. Heavy metals contribute to a variety of adverse health effects due to their high toxicity, having the possibility to get mix with food chain through air water and soil pollution it lead bio accumulation. Conventional treatment methods of metal removal are often limited by their cost and ineffectiveness. Adsorption, the use of activated biomass as adsorbents offers an attractive potential alternative for the removal of heavy metals from textile waste water. Citrus aurantium (orange) peel and aloe barbadensis (aloe vera) gel are naturally occurring and abundant biomass can offer an economical solution for metal removal. In my project, I have used natural adsorbent for the removal of Lead. In which Citrus aurantium gives the maximum lead removal efficiency of about 76%for an period of 90 minutes at 1.5g as a optimized dosage. Where as Aloe barbadensis gives the maximum lead removal efficiacy of about 78% for a period of 90 minutes at 2.0g as optimized dosage. Aloe barbadensis found to be more efficient the Citrus aurantium than Citrus aurantium and providing 78% removal efficiency at 2.0g for a period of 90 minutes. This treatment process would provide the better solution in conservation of health and environment.*

***Key Words*:** **Textile waste water, Heavy metals, Citrus aurantium, Aloe barbadensis, Lead, bio accummulation.**

1. INTRODUCTION

Water is a chemical component and it is as essential for life as air is. The water is necessary and that must be good and it should not contain unwanted impurities or harmful chemical components or bacteria in it. Therefore in order to ensure the availability of sufficient quantity of good quality water, it becomes almost imperative in a modern society, to plan and built suitable water.

Dye and heavy metals are dangerous pollutants found in large quantities in wastewater from textile and paper industries. One lakh varieties of commercial dyes are used in textile, paper, food, leather and many other industries for coloring the products. There are 700,000 tons of effluent wastes produced annually. It is recognized that public perception of water quality is greatly influenced by the color. The color is the first contaminant to be recognized in wastewater. The presence of even very small amounts of dyes in water less than 1ppm for some dyes is highly visible and undesirable.

Some well known toxic metallic elements are arsenic (specific gravity 5.7),iron(specific gravity 7.9), chromium(specific gravity 7.19),cadmium(specific gravity 8.65),lead(specific gravity 11.34) and mercury(specific gravity 13.54).Textile and Garments washing & dyeing sections have been condemned as being one of the world's most offenders in terms of pollution.

Textile industry

India is the world's second major manufacturer of textiles and garments after china. The textile and garment industry in India is one of the oldest manufacturing sectors in the country and is currently it's largest. The textile and garment industry fulfils a pivotal role in the Indian economy. Recently, it was observed that sipcot industries were experiencing severe environmental problems due to textile dyeing, leather tanning, paper and pulp processing, industries, etc.

Textile industry involves wide range of raw materials, machineries and processes to trick the required shape and properties of the final product. The main cause of generation of this effluent is the use of huge volume of water either in the actual chemical processing or during re-processing in preparatory, dyeing, printing and finishing. Textile wastewater pollutants are generally caustic soda, detergents, starch, wax, urea, ammonia, pigments and dyes that increase its BOD, COD, solid contents and toxicity.

Heavy metals in textile waste water

Many investigations was made to ascertain heavy metals concentration in effluent samples collected from textile industries. And it is determined that some concentration of heavy metals present in it. Heavy metals identified in textile waste water are, Zinc (Zn), Copper (Cu), Nickel (Ni), Cadmium (Cd), Chromium (Cr) and Lead (Pb). Effluents discharged from textiles contain a higher amount of metals. These effluents are released on the land as well as discharged into the surface water which ultimately end up in ground water by leaching and lead to contamination of it due to accumulation of toxic metallic components. Thus industrial effluents induce a wide range of environmental problems, more complex and critical health hazards.

Health effects due to heavy metals

Heavy metal toxicity can result in damaged or reduced mental and central nervous function, lower energy levels, and damage to blood composition, lungs, kidneys, liver and other vital organs. Long-term exposure may result in slowly progressing physical, muscular and neurological degenerative processes that mimic Alzheimer's disease, Parkinson's disease, muscular dystrophy, and multiple sclerosis. Allergies are not uncommon and repeated long-term contact with some metals (or their compounds) may cause cancer. For some heavy metals, toxic levels can be just above the background concentrations naturally found in nature. Therefore, it is important to learn about heavy metals and take protective measures against excessive exposure.

Heavy metals are associated with myriad adverse health effects, including allergic reactions (e.g., beryllium, chromium), neurotoxicity (e.g., lead), nephro toxicity (e.g., mercuric chloride, cadmium chloride), and cancer (e.g., arsenic, hexavalent chromium). Humans are often exposed to heavy metals in various waysmainly through the inhalation of metals in the workplace or polluted neighborhoods, or through the ingestion of food (particularly seafood) that contains high levels of heavy metals or paint chips that contain lead.

Use of natural adsorbents

Most of the adsorption researches have been concentrated on the use of bacteria and fungi for the removal of heavy metals. Both viable and inactivecells have been studied. This generally involves culturing of these microorganisms using chemicals. A potential economical alternative would be to use, naturally abundant materials such as waste biomass. These natural materials can be easily processed andused for metal removal, and hence can offer an economical solution to the problem of heavy metal pollution. Low cost naturally available adsorbents like peels of orange, mango, neem barks or leaves coconut shell, etc can be used. The adsorption technique using agricultural wastes, fruit peels or natural biomass are low cost and effective. Metabolisms of adsorbent (fruit peels or agricultural wastes) helps in the heavy metal removal.

2. Materials and Methodology

Materials used

Low cost naturally available adsorbents like peels of Citrus aurantium (orange) peel and Aloe barbadensis (aloe vera) are used. The citrus used as adsorbent is given in figure 1.1 and Aloe barbadensis gel used as adsorbent is given in figure 1.2.

Fig 1: Dried Citrus aurantium peels

Fig 2: Dried Aloe barbadensis gel

Methodology

Samples were collected from dyeing industry and initial characterization is done. Adsorbents are collected and prepared it for treatment of waste water. After that adsorption study using prepared adsorbents in dyeing waste water is conducted. Then characterization of treated waste water is done. Finally the results were analyzed.

3. Experimental procedure

Preparation of orange peel adsorbent

The peels of Citrus aurantium were collected from local juice shops. They were then washed thoroughly with double distilled water to remove dust and other impurities. Then it was sun dried and cut into small pieces and ground to 250 mesh size. After screening they were dried in an oven at 800Cfor 24 hours. Finally activate the dried peels using muffle furnace at 4000C for 30 minutes.

Preparation of aloe vera gel adsorbent

The Aloe barbadensis plants are collected from nearby locality. The Aloe barbadensis gel is extracted from the Aloe barbadensis leaf. They were then washed thoroughly with double distilled water to remove dust and other impurities. Then it was dried . After that they were dried in an oven at 800Cfor 24 hours. Finally activate the dried peels using muffle furnace at 4000C for 30 minutes.

4. Results and discussions

Citrus aurantium has removal efficiency for lead with 76% that is it has higher adsorption capacity towards lead. Aloe barbadensis gel has the removal efficiency for lead with 78% that means aloe barbadensis gel has higher adsorption capacity towards lead while comparing citrus aurantium.

These two natural adsorbent can be used in waste water treatment of the textile effluent and can be re use it in same textile industry itself. The method is cost effective, so can be affordedto large textile industries where traces of heavy metals are present.

Physicochemical parameters

An initial experiment was carried out to determine the preliminary characteristics of textile effluent, the characteristics of raw textile effluent has tabulated below.

Table 1: Physicochemical Param

S.No	Parameter	Value
1	Odour	Unpleasant
2	Temperature	32^0c
3	pH	8
4	TDS	4000mg/l
5	BOD	510mg/l
6	COD	720mg/l
7	Alkalinity	100 mg/l
8	Hardness	210 mg/l

Heavy metals

A study has conducted to determine the heavy metals present in the textile waste water and following are the traces present. The World Health Organisation (WHO) standards for maximum limit also given in the following table.

Table 2: Heavy metals present in the textile waste water

S.No	Heavy metal	Traces present (mg/l)	Permissible limit (As per WHO standards)
1	Lead	0.110	0.1
2	Iron	0.142	0.3
3	Copper	0.921	1
4	Cadmium	0.055	0.05
5	Zinc	3.321	5

Effect of contact time of citrus aurantium on lead removal

The adsorption of lead ion increases with time up to one and half hour and then it becomes almost constant at the end of the experiment. i.e., the maximum uptake of lead is found in the first 60 to 90 min.

Table 3: Optimum time for the removal of lead using citrus aurantiumas a natural adsorbent

S. No .	Contact time (min)	Initial lead conce n-trati on (mg/l)	Final lead concentra -tion (mg/l)	Efficiency of removal (%)
1	30	0.110	0.054	51
2	60	0.110	0.038	65
3	90	0.110	0.026	76
4	120	0.110	0.025	77
5	150	0.110	0.028	77.4
6	180	0.110	0.024	78

The result showed that the adsorption of lead ion increases with time up to 1hour and then it becomes almost constant at the end of the experiment. It can be concluded that the rate of metal binding with biomass is more predominant during initial stages, which gradually decreases and remains almost constant after 150min. Adsorbent dosage is 2mg/100ml.

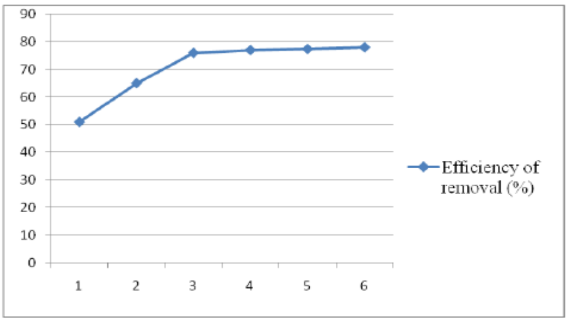

Fig 3: Optimum time for citrus aurantium

Effect of Adsorbent Dosage For Citrus Aurantiumon Lead Removal

The adsorption of lead ions increased with the adsorbent dosage and at adsorbent dosage above 2mg/100ml reached equilibrium. Further increment in adsorbent dose did not cause significant improvement in adsorption.

Table 4: Effect of dosage of lead removal using citrus aurantium

S. No.	Adsorbent dosage (mg/100ml)	Initial lead concentration (mg/l)	Final lead concentration (mg/l)	Removal efficiency (%)
1	0.5	0.110	0.042	62
2	1	0.110	0.033	70
3	1.5	0.110	0.026	76
4	2	0.110	0.0248	77.5
5	2.5	0.110	0.0242	78
6	3	0.110	0.0242	78

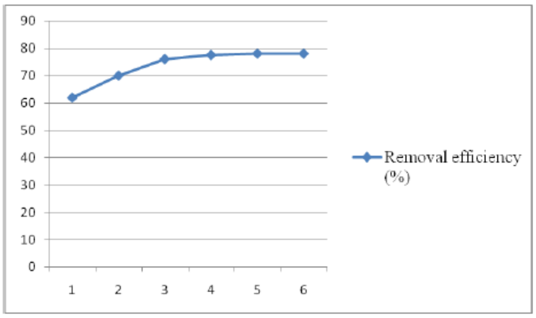

Fig 4: Effect of dosage of lead removal using citrus aurantium

Effect of contact time of aloe barbadensis gel on lead removal

The adsorption of lead ion increases with time up to one and half hour and then it becomes almost constant at the end of the experiment. i.e., the maximum uptake of lead ion is found in the first 60 to 90 min.

The result showed that the adsorption of lead ion increases with time up to 1hour and then it becomes almost constant at the end of the experiment. It can be concluded that the rate of metal binding with biomass is more predominant during initial stages, which gradually decreases and remains almost constant after 150min. Adsorbent dosage is 2mg/100ml.

Table 5: Effect of contact time of aloe barbadensis gel on lead removal

S.No.	Contact time (min)	Initial lead concentration (mg/l)	Final lead concentration (mg/l)	Removal efficiency (%)
1	30	0.110	0.045	59
2	60	0.110	0.027	75
3	90	0.110	0.024	78
4	120	0.110	0.0227	79.1
5	150	0.110	0.022	80
6	180	0.110	0.022	80

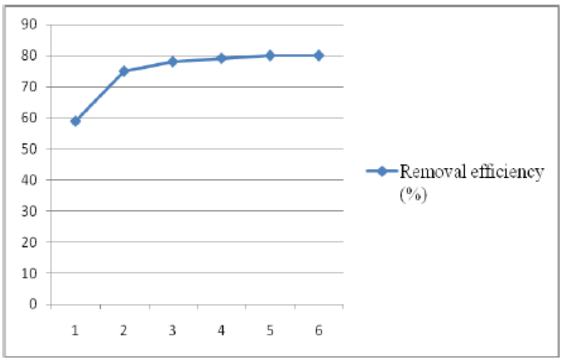

Fig 5: Effect of contact time of aloe barbadensis gel on lead removal

Effect of adsorbent dosage of aloe barbadensis gel on lead removal

The adsorption of lead ions increased with the adsorbent dosage and at adsorbent dosage above 0.8mg/100ml reached equilibrium. Further increment in adsorbent dose did not cause significant improvement in adsorption.

Table 6: Effect of adsorbent dosage of aloe barbadensis on lead removal

s.no	Adsorbent dosage (mg/100ml)	Initial lead concentration (mg/l)	Final lead concentration (mg/l)	Removal efficiency (%)
1	0.5	0.110	0.049	55
2	1.0	0.110	0.042	62
3	1.5	0.110	0.030	73
4	2.0	0.110	0.024	78
5	2.5	0.110	0.023	79

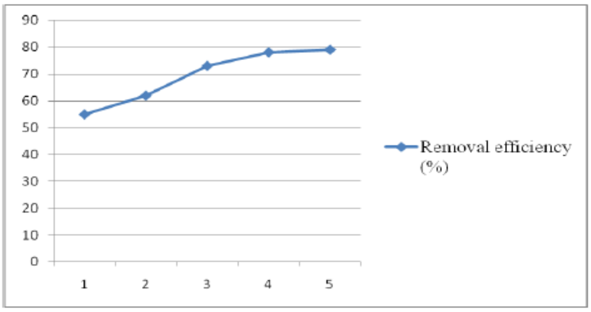

Fig 6: Effect of adsorbent dosage of aloe barbadensis gel on lead removal

5. CONCLUSION

The study on heavy metal removal by adsorption using Citrus aurantium (orange) peel and Aloe barbadensis (aloe vera) peel were carried out.

The major findings of the study were:

• Citrus aurantium has removal efficiency for lead with 76% removal efficiency in removal of lead from textile waste water. The effects of contact time and adsorbent dosage on the lead uptake/ removal efficiency were studied. The optimum contact time of 60-90 min obtained Citrus aurantium The maximum removal efficiency was obtained with adsorbent dosage of 1.5 g.

• Aloe barbadensis gel has removal efficiency for lead with 78% removal efficiency in removal of lead from textile waste water. The effects of contact time and adsorbent dosage on the lead uptake/ removal efficiency were studied. The optimum contact time of 60-90 min obtained for Aloe barbadensis gel. The maximum removal efficiency was obtained with adsorbent dosage of 2.0.

• Citrus aurantium has less removal efficiency towards Lead compared to Aloe barbadensis gel.

REFERENCES

[1] Abdelwahab O.(2007),'Kinetics and isotherm studies of copper (II) removal from wastewater using various adsorbents', Egyptian Journal of Aquatic Research, Vol. 33, pp.125-143.

[2] Annadurai G.,Juang R. S., Lee D. J. (2003),'Adsorption of heavy metals from water using banana and orange peels', Water Science and Technology Journal, Vol. 47, Issue.1, pp.185-190.

[3] Bernard E. and Jimoh A. (2013),'Adsorption of Pb, Fe, Cu, and Zn from industrial electroplating wastewater by orange peel activated carbon', International Journal of Engineering and Applied Sciences, Vol. 4, No. 2, pp.1-12.

[4] Castro R. S. D., Caetano L. and Ferreira G. (2011),'Banana peel applied to the solid phase extraction of copper and lead from river water: pre concentration of metal ions with a fruit waste', J. Industrial and engineering chemistry research, Vol. 50, No.6, pp.3446–3451.

[5] Chandran Prince Jebadass Isaac and A. Sivakumar (2013),'Removal of lead and cadmium ions from water using Annona squamosa (Custard apple) shell: kinetic and equilibrium studies', Water Science Journal, pp.456-462.

[6] GuptaV. K., Arunima Nayak(2012),'Cadmium removal and recovery from aqueous solutions by novel adsorbents prepared from orange peel and Fe2O3nanoparticles', Chemical Engineering Journal,Vol. 180, pp.81–90.

[7] Husoon Z. A., M. N. A. Al-Azzawi and S. A. K. Al-Hiyaly (2013),'Investigation Biosorption Potential of Copper and Lead from Industrial Waste Water Using Orange and Lemon Peels', Journal of Al-Nahrain University Science, Vol. 16, pp.713-179.

[8] Jai M Paul Dr., Jis Jimmy, Josento M Therattil, Linda Regi and Shirin Shahana (2017), 'Removal of Heavy Metals Using Low Cost Adsorbent's'. IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Vol. 14, Issue.3, pp.48-50.

[9] Khalfaoui A. and Meniai A.H.(2012),'Application of chemically modified orange peels for removal of copper(II) from aqueous solutions', Theoretical Foundations of Chemical Engineering,Vol. 46,Issue.6,pp.732–739.

[10] Mahakalkar A. S., Sapna N. Nandeshwar and Rashmi R. Gupta (2014),'Removal of iron from industrial and municipal waste water using low cost adsorbent prepared from waste orange peel', Archives of Applied Science Research, Vol. 6, No.5, pp.26-35.

[11] 11. Nurul Aini Zainol Abidin, Puganeshwary Palaniandy, Mohd Suffian Yusoff and Mohd Nordin Adlan (2016) 'A Review Regarding Treatment of Water from Kerian River using Composite Adsorbent', International Journal of Scientific Research in Knowledge, Vol. 4, pp.21-27.

[12] 12. Olugbenga Solomon Bello, Mohd Azmier Ahmad (2011),'Adsorption of dyes from aqueous solution using chemically activated Mango peels', IPCBEE, Vol. 6, pp.1-9.

[13] 13. Pollard S. J. T., Fowler G. D., Sollars C. J. and Perry R. (1992),'Low cost adsorbents for waste and wastewater treatment: a review', Journal of Science of the total environment, Vol. 116, pp.31-52.

[14] 14. Rao K. S., M. Mohapatra, S. Anand and P. Venkateswarlu (2010),'Review on cadmium removal from aqueous solutions', International Journal of Engineering, Science and Technology, Vol. 2, No.7, pp.81-103.

[15] Saman Khan, Abida Farooqi, M. Ihsan Danish & Akif Zeb (2013),'Biosorption of copper (II) from aqueous solution using Citrus sinensis peel and wood sawdust and its utilization in purification of drinking and waste water', International Journal of Recent Research and Applied Studies(IJRRAS), Vol. 6, Issue.2.

[16] Tesfaye Teka and Semegn Enyew (2014),'Study on effect of different parameters on adsorption efficiency of low cost activated orange peels for the removal of methylene blue dye', International Journal of Innovation and Scientific Research,Vol. 8, No.1, pp.106-111.

[17] Xiaomin Li. Yanru Tang, Xiuju CaoDandan, LuFang Luo, Wenjing Shao(2008),'Preparation and evaluation of orange peel cellulose adsorbents for effective removal of cadmium, zinc, cobalt and nickel' Colloids and Surfaces A: Physicochemical and Engineering,Vol. 317, Issue.1, pp.512–521.

[18] Zhexian Xuan,Yanru Tang,Xiaomin Li,Yinghui Liu, and Fang Luo(2006), 'Study on the equilibrium, kinetics and isotherm of biosorption of lead ions onto pretreated chemically modified orange peel', Biochemical Engineering Journal,Vol. 31, Issue.2, pp.160–164.