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Biodegradation of Tannery effluent using Prosopis juliflora

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Abstract: Untreated industrial effluents released into the environment are the serious problems in the developing countries. In this study, different solvents such as methanol, ethanol, chloroform and benzene were used for extracting the phytochemical constituents of *Prosopis juliflora* and were analyzed. Phytochemical analysis showed the presence of glycosides and carbonyl compounds in all the four extracts. Phenol was present only in the extracts of benzene. Flavanoids were present in chloroform extract. These extracts were used for treating the toxic chemicals present in leather industry effluent. Results revealed that considerable reduction in various parameters of effluent. Ethanolic extracts of *Prosopis julifolra* reduced nearly 78% of Total dissolved solids present in effluent. Methanolic extract had showed good reduction in hardness (78%). Benzene extract reduced 89% of chloride content present in effluent and it also reduced sulphate content (78%). Hexavalent chromium was greatly reduced by ethanolic and chloroform extracts. Ethanolic extracts showed 80% reduction of nitrate content.
Keywords: *Prosopis juliflora*, Total dissolved solid, chloride, nitrate, sulphate, chromium, effluent.

Introduction

In developing countries, many industries are operated as small and medium level industries. The small scale industries discharge the effluent directly into the environment without any pretreatment[1]. Many methods are used for treating the effluent includes activated sludge process, microbial degradation, enzymatic treatment[2,3]. Electroplating and leather industries are the major cause for the high influx of chromium to the biosphere[4]. Generally, industrial waste contains both hexavalent and trivalent forms of chromium. The hexavalent chromium is of particular concern due to its great toxicity. It is known to be carcinogenic and mutagenic to living organisms[5]. Thus it is necessary to remove or recover the chromium before disposal of industrial waste. Growth of *Aspergillus oryzae* in the tannery effluent, and removal chromium were also analyzed[6]. The harmful hexavalent chromium was removed by adsorption process using saw dust and charcoal as adsorbent[7].

Among all these techniques, adsorption is the most promising technique and feasible alternatives. It was used for removing harmful chemicals from aqueous solution. Over last few years, many natural adsorbents have been tested for removing heavy metals. Laboratory studies had revealed the ability of algae[8,9,10] and bacteria in the removal of heavy metals from industrial effluent. Recently laboratory studies had recognized the capability of plant extracts on the treatment of domestic waste water treatment[11,12]. Thus there is a need for the development of low cost, easily available material that can remove the harmful chemicals present in industrial effluent. In this study, leaf extracts of *Prosopis juliflora* were analyzed in the removal of toxic chemicals present in tannery effluent.

Experimental

Collection of sample

Leather industry effluents were collected from the surrounding areas of Nagalkeni village, Pallavaram, Chennai, India and stored in refrigerator for avoiding further contamination in the waste water. The leaves of *Prosopis juliflora* were collected from Madambakkam village and were separated manually. They were dried under sun light for three days. After complete drying, it was made as a fine powder and was stored.

Preparation of plant extract

The powdered samples were soaked in different solvents such as methanol, ethanol, chloroform and benzene for 48 hrs and the extracts were filtered out using whatman No.1 filter paper.

Phytochemical analysis

The phytochemical constituents of plant material was analysed for both the extracts.

Steroids, triterpenoids and terpenoids were estimated by Salkowski test. Phenol and flavanoids were estimated by ferric chloride test. Neutral ferric chloride test was followed for tannins. Aminoacid was estimated by ninhydrin test. Carboxylilc acid was analysed by sodium bicarbonate test. Molisch's test was performed for estimating glycosides. Cardiac glycosides were estimated by Killer Killani test. By Borntrager's test anthraquinone was analyzed.

Estimation of carbonyl

Plant extract was treated with 2,4 diphenyl hydrazine and was shaked well. Fromation of yellow crystals confirms the presence of carbonyl groups.

Saponin Test

Distilled water was added to extract and heated to boil and mixed vigorously. Frothing confirms the presence of saponins.

Coumarin Test

Extract was treated with 1N NaOH or KOH. Appearance of dark yellow color confirms the presence of coumarin.

Phlobatanin Test

Extract was dissolved in water and filtered. Filtrate was boiled with 2% HCl. Red precipitate gives confirmation of the presence of phlobatanin.

Treatment of effluent

Tannery and paint industry effluent was treated with various plant extracts and some important parameters were checked.

Estimation of TDS

The sample was filtered and the sediment leftover on the filter was scrapped off and dried in oven. Then the dry weight of the sediment was measured.

Determination of Hardness

An aliquot containing 25ml of extract was dissolved in 50ml of distilled water and 1 or 2 drops of EBT indicator was added to it. The solution was titrated with EDTA solution till the colour changes from reddish to blue tinge.

Analysis of Sulphate concentration

Sulphate concentration was checked by nephlometry method. About 100ml of sample was treated with 20ml of buffer solution A(30 g of $MgCl_2$ was dissolved in 5g of sodium acetate, 1g of KNO_3 and 20ml of CH_3COOH in 500ml distilled water). A spoonful of $BaCl_2$ was added to it. The turbidity was measured. Using standard graph, the concentration of sulphate was measured.

Determination of Nitrate level

Aliquot containing 50ml of sample was added to 1ml of HCl and OD was measured using calorimeter. The nitrate concentration was measured for the given sample using standard graph.

Determination of chromium.

Hexavalent chromium was measured spectrophotometrically by diphenyl carbizide method which is nearly specific for Cr(VI) Adding diphenyl carbized solution to samples develops a pink color which can be measured with a UV-spectrophotometer at 540nm.

Estimation of chloride

Ten milliliter of effluent samples in a conical flask was taken and 1ml potassium chromate was added to get light yellow color. It was then titrated with standard silver nitrate solution till color change from yellow to brick red.

Results & Discussion

Tannery effluents are one of the major polluting compounds of environment. In this study, leather effluents were treated with various extracts of *P.juliflora*.

Phytochemical Analysis

The phytchemical analysis showed that carbonyl and glycoside were present in all the four extracts. Phenol was present in the methanolic, ethanolic and chloroform extracts whereas flavanoids were present only in chloroform extract but coumarin was absent in that. Saponin and terpenoids were present in methanolic and ethanolic extract. Terpenoids were also present in benzene extract. (Table.1)

Table.1 Phytochemical analysis of *Prosopis juliflora*

S.No	Plant Constituents	Inference			
		Methanol	**Ethanol**	**Chloroform**	**Benzene**
1	Steroid	-	-	-	-
2	Triterpenoids	-	-	-	-
3	Terpenoids	+	+	-	++
4	Phenol	++	+++	++	-
5	Flavanoid	-	-	+++	-
6	Coumarin	++	++	-	+++
7	Tannin	-	-	-	-
8	Phlobatanin	-	-	-	-
9	Aminoacid	-	-	-	-
10	Carboxylic acid	-	-	-	-
11	Glycoside	+++	+++	++	++
12	Cardiac glycoside	-	-	-	-
13	Carbonyl	+++	+++	+++	+++
14	Saponins	++	+	-	-
15	Anthraquinone	-	-	-	-

(Highly Prominent= +++; Medium amount= ++; Fewer amount= +; Absent= -)

Table.2 Plant Extracts

S.No	Plant	Solvent	Extract
1	*Prosopis juliflora*	Methanol	PJM
2	*Prosopis juliflora*	Ethanol	PJE
3	*Prosopis juliflora*	Chloroform	PJC
4	*Prosopis juliflora*	Benzene	PJB

Table.3 Details of effluent

S.No	Place of effluent collection	Name of effluent
1	Leather industry effluent collected at industry	E1
2	Leather effluent released in drainage	E2
3	Leather Effluent released at fresh water channel	E3

Table.4 Effect of plant extracts on tannery effluent (E1)

S .No	Parameters	Untreated effluent	PJB	PJE	PJC	PJM
1	TDS (mg/l)	2562	634	572	735	637
2	Total hardness (mg/l)	2100	780	750	740	690
3	Calcium hardness (mg/l)	1400	490	500	460	490
4	Magnesium hardness (mg/l)	700	290	250	280	200
5	Chloride (mg/l)	2299.54	494.90	499.9	504.89	479.90
6	Sulphate (mg/l)	3400	750	760	920	760
7	Chromium(VI) (mg/l)	2562	634	572	735	637
8	Nitrate (mg/l)	2100	780	750	740	690

Table.5 Effect of plant extracts on tannery effluent (E2)

S .No	Parameters	Untreated effluent	PJB	PJE	PJC	PJM
1	TDS (mg/l)	3353	743	877	746	637
2	Total hardness (mg/l)	3750	840	890	820	820
3	Calcium hardness (mg/l)	2000	610	670	590	590
4	Magnesium hardness (mg/l)	1750	230	220	230	230
5	Chloride (mg/l)	1949.6	439.91	489.90	319.93	444.91
6	Sulphate (mg/l)	2400	760	950	940	920
7	Chromium(VI) (mg/l)	7650	3000	3100	3500	3500
8	Nitrate (mg/l)	400	113	122	105	113

Table.6 Effect of plant extracts on tannery effluent (E3)

S .No	Parameters	Untreated effluent	PJB	PJE	PJC	PJM
1	TDS (mg/l)	1737	400	359	500	500
2	Total hardness (mg/l)	3250	1110	1110	1120	1090
3	Calcium hardness (mg/l)	1990	650	610	690	540
4	Magnesium hardness (mg/l)	1260	460	500	430	550
5	Chloride (mg/l)	1499.7	144.97	174.96	279.94	174.96
6	Sulphate (mg/l)	1700	980	730	980	960
7	Chromium(VI) (mg/l)	6250	3500	3500	2750	2750
8	Nitrate (mg/l)	125	50	50	50	50

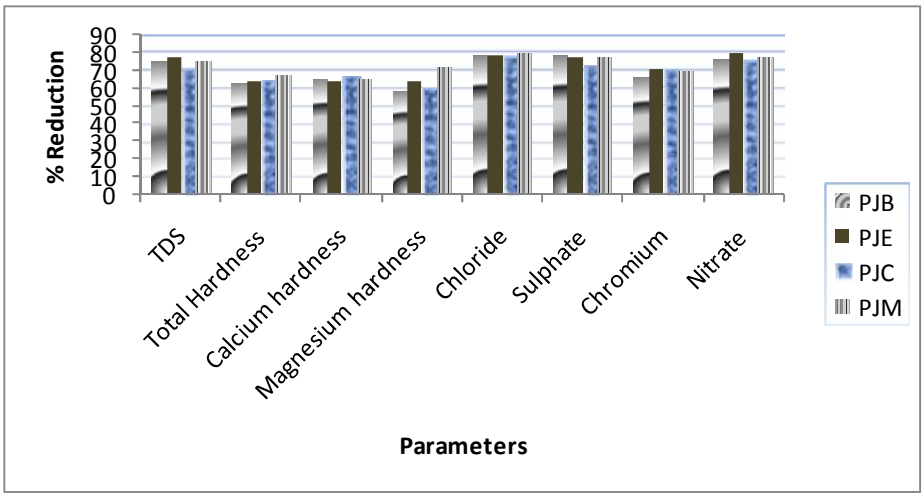

Fig.1 Percentage reduction of various parameters in treated effluent (E1)

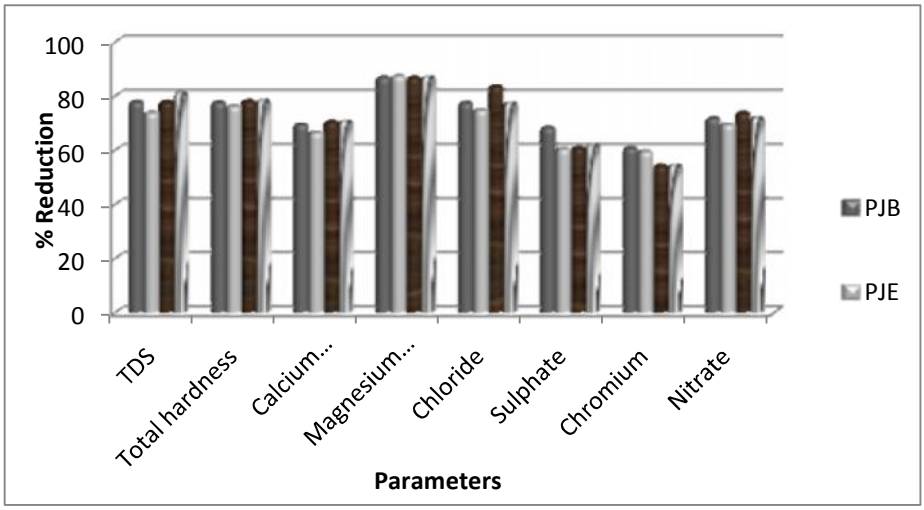

Fig.2 Percentage reduction of various parameters of effluent after treatment (E2)

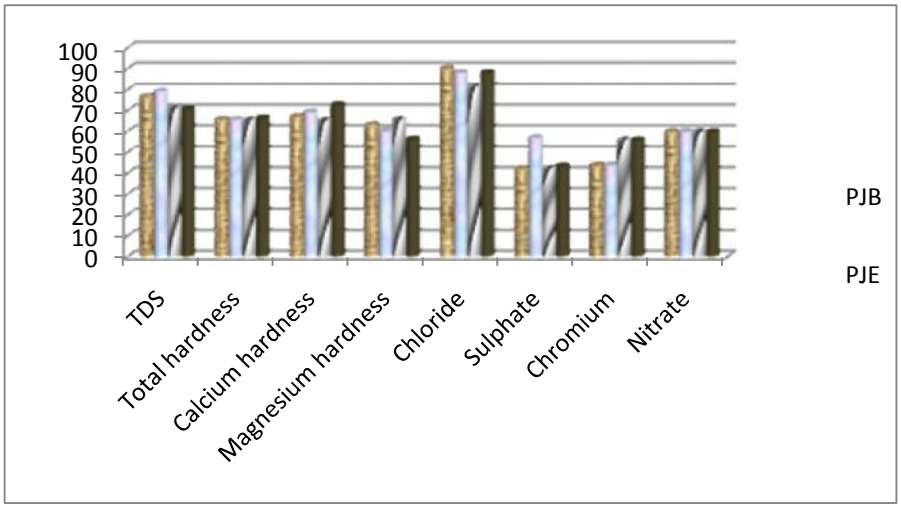

Fig.3 Percentage reduction of various parameters of effluent after treatment (E3)

After treating the leather effluent with plant extracts, toxic chemicals were reduced enormously by all the extracts.

TDS

TDS stands for total dissolved solids, and represents the total concentration of dissolved substances in water. TDS is made up of inorganic salts, as well as a small amount of organic matter. Results showed that PJE has good reduction (78%) in TDS present in E1 (572 mg/l) and E3 (359 mg/l). In E2, PJM showed 80% of Reduction in TDS (637 mg/l). (Table.1,2,3,4,5 &6) (Fig.1,2 and 3).

Total Hardness

Water hardness is the traditional measure of the capacity of water to react with soap, hard water requiring considerably more soap to produce a lather. Hard water often produces a noticeable deposit of precipitate (e.g. insoluble metals, soaps or salts) in containers, including "bathtub ring". It is not caused by a single substance but by a variety of dissolved polyvalent metallic ions, predominantly calcium and magnesium cations, although other cations. Plant extracts reduced hardness of the effluents in a considerable amount. In this study, total hardness of the effluent sample was reduced (68%) by PJM in E1 (690 mg/l) and in E3 (1090mg/l) and E3 (820mg/l). PJC has also reduced hardness in E2 (820 mg/l). (Table.1,2,3,4,5 &6) (Fig.1,2 and 3).

Chloride

Every water supply contains some chloride. Chloride is common in nature, generally as a salt. Most chloride found in nature is in the oceans. Chloride is needed for good health and may be important for kidney health, the nervous system and nutrition. There is no known health effects associated with chloride. However, the sodium often associated with chloride can be a concern to people suffering from heart disease or kidney disease. Chloride concentrations in excess of about 250 mg/l (WHO standard for drinking water) can give rise to detectable taste in water. As per EPA 1986, the permissible limit of chloride for inland surface water is about 1000mg/l and 600 mg/l for on land for irrigation. In this study, nearly 89% of chloride was reduced by PJB (144.97mg/l) in E3. PJM reduced 79% of chloride content present in E1(479.9 mg/l). Whereas PJC showed 82% of chloride reduction in E2 (319.93mg/l). (Table.1,2,3,4,5 &6) (Fig.1,2 and 3).

Sulphate

High concentrations of sulphate may interfere in the efficiency of chlorination in some water supplies. These bacteria produce hydrogen sulphide that results in an unpleasant taste and odor (rotten egg smell). Hydrogen sulphide also increases the corrosive properties of water. The permissible sulphate level of effluent into inland surface water is 1500mg/l as per EPA, 2002. In this study, sulphate content was reduced greatly by the PJB in E1 (750mg/l) and E2 (760mg/l) whereas in E3, PJE reduced 56% of sulphate content (730 mg/l). (Table.1,2,3,4,5 &6) (Fig.1,2 and 3).

Hexavalent chromium

Chrome in the hexa-valent form is very toxic. It is quite intriguing that contaminated field by industrial effluent show a mobilization ration of less than 5 (potentially toxic) for selected plant specious. As per EPA the maximum allowable limit of Cr+6 in treated effluents is 2mg/l. PJE and PJC showed 71% reduction in hexavalent chromium (3000mg/l). In E2, PJB and PJE showed 58&59% reduction of chromium VI (3000& 3100mg/l) while in E3, PJC and PJM showed 55% reduction of chromium VI (2750mg/l). (Table.1,2,3,4,5 &6) (Fig.1,2 and 3).

Nitrate

High nitrate levels in drinking water pose a health risk to infants because they may cause methemologlobinemia, a condition known as blue baby syndrome. High nitrate levels interrupt the normal body processes of some infants. Nitrate becomes toxic when it is reduced to nitrite, a process that can occur in the stomach as well as in the saliva. Infants are especially susceptible because their stomach juices are less acidic and therefore are conducive to the growth of nitrate-reducing bacteria. Nitrate was considerably reduced (80%) by PJE (105mg/l). In E2, PJC showed 72% of reduction of nitrate content (105mg/l). In case of E3, all the extracts reduced nearly 59% of nitrate content (50mg/l). (Table.1,2,3,4,5 &6) (Fig.1,2 and 3).

Conclusion

Extracts of *Prosopis juliflora* are the good reducing agents of harmful factors present in the leather industry effluent. As the availability of the plant in India is enormous, it could be used for treating the effluents in an economic way. Further more work may be carried out to find its efficacy in reducing other heavy metals present in effluents.

References

1. Quek S.Y, Wase D. A. J and Forster C.F., The use of sago waste for the sorption of lead and copper., Water SA, 1998, 24 (3), 251-56.
2. Ambatkar Mugdha and Mukundan usha., Enzymatic treatment of wastewater containing dyestuffs using different delivery systems, 2012, Sci.Revs.Chem.Commun., 2(1), 31-40.
3. Rajasundari K and Murugesan R., Decolourization of Distillery Waste Water – Role of Microbes and their Potential Oxidative Enzymes (Review)., J.Appl.Environ.Biol.Sci, 2011 1(4), 54-68.
4. Gyawali, Rajendra Lekhak, H. D., Chromium tolerance of rice (*Oryza sativa* L) cultivars from Kathmandu valley, Nepal., Scientific World, 2006, 4, 102-108.
5. Nakano Y, Takeshita K, Tsutsumi T., Adsorption mechanism of hexavalent chromium by redox within condensed tannin gel, Water Research, 2001, 35 (2), 496-500.
6. Nouri Sepehr M, Nasseri S, Mazaheri Assadi M and Yaghmaian K., Chromium bioremoval from tannery industries effluent by *Aspergillus oryzae.*, Iran. J. Environ. Health. Sci. Eng., 2005, 2(4), 273-279.
7. Dhungana T.P and Yadav P.N., Determination of Chromium in Tannery Effluent and Study of Adsorption of Cr(VI) on Sawdust and Charcoal from Sugarcane Bagasses, J. Nepal Chem. Soc., 2009, 23, 93-101.
8. Tobin J. and Roux J., Mucor biosorbent for chromium removal from tannery effluent. Water. Res.,1998, 32, 1407 – 1416.
9. Venkobachear, C., Metal removal by waste biomass to upgrade wastewater treatment plant. Water. Sci. Technol., 1990, 22, 319-320.
10. Pillichshammer M, Pumple T, Eller K, Klima J. and Schinner F., Biosorption of chromium to fungi. Biometals , 1995, 8 (2), 117-121.
11. Md Saduzaman, Sharmila S and Jeyanthi Rebecca L, Efficacy of leaf extract of *Moringa oleifera* in treating domestic effluent, J.chem and pharm Res., 2013, 5(2), 139-143.
12. Sharmila S, Jeyanthi Rebecca L and Md Saduzzaman, Biodegradation of domestic effluent using different solvent extracts of *Murraya koenigii*, , J.chem and pharm Res., 2013, 5(2), 279-282.

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