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A study on the physico-chemical characteristics of Tannery Waste Water at Tiruchirappalli district

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ABSTRACT

The waste water generated by the tanning industry are the potential sources of pollution in Tiruchirappalli district. The tannery effluent can cause serious impact to water and soil. This study evaluates the physico-chemical characteristics of tannery effluent and soil. The chemical and physical parameters and water quality index of tannery wastewater were observed to be toxic as it contains large values of organic and inorganic chemical elements. The tannery effluent contains large values of TDS, EC, anions and cations. The major pollutants in tannery effluents are high chlorides, sulphide and total dissolved solids (TDS). The organic impurities in tannery wastewater are the cause for its bad odour. Tannery wastewater polluted soil was analysed and found to have high values of PH, ESP(Exchangeable sodium percentage), EC, sodium, chloride, sodium adsorption ratio, micronutrients and macronutrients and low values of organic matter, moisture content, phosphorus, potassium, nitrogen, than the garden soil Unpolluted soil.

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INTRODUCTION

The rapid progress made in industrialization without adequate environmental protection measures led to an increase in the toxic value of water, which, in turn, results in a lack of quality water. Industrial wastewater is one of the problems presently facing India, and several efforts are being seriously followed to control it at various industries in our country. Wastewater produced by the industries are the major sources of pollution.

Industrial effluents contribute to the amount of pollution to water and soil deterioration, and their prevention is the topic of exchange and guideline in numerous different nations. Tannery wastewater are one of the most hard-to-treat waste waters by virtue of their extensive amount of biodegradable and frequently poisonous substances such as dyes, surfactants, heavy metals, detergents, and other additives. Tanneries are classified under the category "Redmost polluting industries". The effluent of tanning industries having an immense measure of water utilization and exceptionally high contamination loads might be portrayed by a few key parameters, including harmful poisons displaying poisonous quality.

The traditional leather tanning procedure is profoundly contaminating as it produces tremendous measures of natural and dangerous toxins. These pollutants, which are, for the most part, contained in the wastewater all through by tanneries, are genuine harm to the earth. The tannery wastewater isn't dealt with appropriately, can make major issue soil and water bodies. The high measure of salt contained in the emanating, for instance, can expand soil saltiness, lessen ripeness and harm cultivating in enormous regions. Tanneries likewise produce

destructive gases, residue and an enormous measure of solid waste. In conventional vegetable tanning, barks and nuts are used throughout the whole tanning process instead of chromium. It was estimated that vegetable tanning is 40 percent, while 60 percent are chromium-based tanning.

Tamil Nadu is a major contributor to this sector, and 60% of the tanneries are in this state, which are concentrated as large clusters in North Arcot District, Pallavaram, Erode, Tiruchirapalli and Dindigul. The effluent has high polluting potential owing to the inherent nature of tanning processes in which, various chemicals were used. The Tamilnadu Pollution Control Board has stipulated stringent standards for the tannery effluent discharged outside. The present investigation essentially deals to study the physical and chemical parameters of tannery polluted soil and wastewater. The growing demand for a clean environment, especially in the context of increasing population, necessitates early measures for the control of pollution from tanneries. Several researchers have studied the pollution caused by the tanning industry. This research work is an attempt to evaluate the characteristics of treated tannery effluent and soil. The present investigation was carried at Tiruchirappalli district, Tamilnadu.

MATERIALS AND METHODS

The details of the collection of tannery effluent and analytical techniques followed for the water and soil samples collected in a tannery at Tiruchirappalli district during the year 2017 between the months of January and June, for investigation are explained.

Collection of tannery effluent

The Tanning Industry which is situated at Sembattu 8 km south of Tiruchirappalli Junction, was selected for collecting effluent samples. The tannery produces semi-finished tanned leathers. The groundwater is the main source for various leather processing operations. The water sample for the present examination was gathered from this tannery in plastic containers (20L). After gathering, the effluent water was promptly shipped to the laboratory for examination.

Preservation of water sample

Polystyrene bottles for test safeguarding were completely cleaned by flushing with 8M, HNO3 pursued by continued washing with distilled water. The bottles were washed thrice with sample water before the preservation. During the time of the investigation, the water sample were preserved according to the preservation technique (Apha, 1990) (Table 1).

Physico-chemical characteristics of the effluent

The physical and chemical characters such as total solids, electrical conductivity, total dissolved solids, P^H, total suspended solids, sodium, alkalinity, total hardness, potassium, calcium, sulphide,phosphate, magnesium, Chloride, dissolved oxygen, bicarbonate, phosphate, dissolved carbon-di-oxide, COD, BOD, and total chromium were analysed according to (Apha, 1990) standard protocols (Table 2). The tannery wastewater as filtered through Whatman No.1 filter paper in all cases before analysis. Unpolluted groundwater was collected from the bore well in Jamal Mohamed College campus for control, whose parameters were also analysed.

Collection and analysis of Soil sample

The soil samples were collected from the same tannery. Visual perception of the field was made for sampling. A V-shaped cut was made with a spade to expel 1 to 2 cm cut of soil. The surface soil samples were gathered from 0-15 cm profundity by spade and put in a clean bucket. The collected soil samples were transported to the laboratory for analysis. Unpolluted soil sample obtained from the garden in Jamal Mohamed College campus was taken as control, whose physico-chemical characteristics were also analysed according to the analytical methods (Jackson, 1973; Lindsay and Norvell, 1978; Jackson *et al.*, 1986; Natusch and Hopke, 1983; Piper, 1944; Mcgeorge, 1954; Trivedy and Goel, 1984) (Table 3).

Statistical analysis

The results obtained in various treatments were tested through the method of analysis of Variance (ANOVA) Steel and Torrie (1960). The ANOVA was conducted both within and between blocks to ascertain the effect of the control and the different concentrations of effluent on the degree of inhibition. The experimental data was statistically analysed by adopting the standard procedure Panse and Sukhatme (1967). Wherever the results were significant, the critical difference (CD) was worked out at 5% probability level and reported.

RESULTS AND DISCUSSION

Physico-chemical characteristics of tannery effluent and groundwater

The chemical and physical characteristics of wastewater and control are exhibited in Table 4. The pH of the treated tannery effluent was 7.7 while that of the groundwater was 7.1. The EC of the sample was high (16.9 mS/cm), indicating the presence of a high concentration of ionic substances in the tannery effluent, while the electrical conductivity of the groundwater was 1.35 (mS/cm). The TDS in

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Table 1: Water sample preservation techniques

S. No	Parameters	Sample Volume (ml)	Container used	Preservation method
1.	P^H	100	Polystyrene	Measure within
2.	Dissolved oxygen	100	Polystyrene	4hrs
3.	COD	500	Polystyrene	Add H2SO4 to adjust the pH upto 2 and refrigerate
4.	Phosphate	500	Polystyrene	Add 20mg of HgCL2 and refrigerate
5.	Trace inorganic	500	Polystyrene	Add 2.5ml Con. HNO3 and refrigerate

Table 2: Components of the experimental programme and analytical techniques

S. No	Parameters	Frequency	Analytical method
1.	P^H	Daily	pH meter
2.	Alkalinity	Daily	Titrimetric
3.	Potassium	Daily	Flame Photometer
4.	Total suspended solids	Daily	Gravimetric
5.	Total dissolved solids	Daily	Gravimetric
6.	Total hardness	Daily	Titrimetric
7.	Electrical conductivity	Daily	Conductivity bridge
8.	Sulphide	Daily	Flame Photometer
9.	Calcium	Daily	Flame Photometer
10.	Total solids	Daily	Gravimetric
11.	Sodium	Daily	Flame Photometer
12.	Bicarbonate	Daily	Titrimetric
13.	Phosphate	Daily	Spectrophotometric
14.	Chloride	Daily	Titrimetric
15.	Magnesium	Daily	Flame Photometer
16.	Dissolved oxygen	Daily	Titrimetric
17.	Dissolved Carbon dioxide	Daily	Titrimetric
18.	Chemical Oxygen Demand	Fortnightly	COD mantle
19.	Biological Oxygen Demand	Fortnightly	BOD chamber (20 C)
20.	Total chromium	Daily	Colorimetric

the tannery wastewater were very high (11,100 mg 1-1) when compared to the control.

The contents of potassium, sulphide, sodium, magnesium and chloride in the sample values were higher than when compared to the unpolluted water. The COD of the tannery wastewater was higher (390mg1-1) those in the bore well water (control)(23.1mg1-1). The dissolved oxygen in the tannery wastewater was lower than when compared to the bore well water (control) (2.5). The chromium content was present in the tannery effluent (0.009). (Figures 1, 2, 3, 4 and 5).

The results indicate that solitary four parameters (PH, electrical conductivity, Magnesium, calcium) were inside the BIS standards out of the 20 parameters. The total solids, alkalinity, total suspended solids, bicarbonate, phosphate, total hardness, dissolved carbon-di-oxide and biological oxygen demand were also higher.

Physical and chemical characteristics of polluted and un-polluted soil

The polluted soil (tannery soil) showed high values of pH, EC and hardness when compared to unpolluted soil (garden soil). The polluted soil showed low values of nitrogen, phosphate and high values of sodium, chloride, manganese and minor elements when compared to unpolluted soil due to the addition of various chemicals during the processing of

Table 3: Details of the analytical method for soil samples

S. No	Parameters	References
1.	P^H	(Jackson *et al.*, 1986)
2.	EC	(Jackson, 1973)
3.	Moisture content	(Jackson, 1973)
4.	Organic matter	(Trivedy and Goel, 1984)
5.	Organic carbon	(Trivedy and Goel, 1984)
6.	Nitrogen	(Jackson, 1973)
7.	Phosphorus	(Piper, 1944)
8.	Potassium	(Natusch and Hopke, 1983)
9.	Sodium	(Natusch and Hopke, 1983)
10.	Calcium	(Jackson, 1973)
11.	Chloride	(Jackson, 1973)
12.	Zinc	(Lindsay and Norvell, 1978)
13.	Iron	(Lindsay and Norvell, 1978)
14.	Manganese	(Lindsay and Norvell, 1978)
15.	Copper	(Jackson, 1973)
16.	Magnesium	(Piper, 1944)
17.	Sodium Adsorption Ratio	(Mcgeorge, 1954)
18.	Exchangeable Sodium	(Mcgeorge, 1954)

Table 4: Physical and chemical characteristics of tannery waste water and groundwater

S. No	Parameters	Tannery effluent	Ground water	BIS*
1.	P^H	7.7	7.1	7 to 8.5
2.	EC (mS/cm)	16.9	1.35	400
3.	Total solids (mg 1-1)	11,100	1.1	
4.	Total dissolved solids ”	10,210	1.2	500
5.	Total suspended solids ”	578	0.20	
6.	Total hardness ”	1807	256.52	300
7.	Alkalinity ”	139	122	
8.	Sodium ”	2095	25.2	20
9.	Potassium ”	42	4.48	20
10.	Calcium ”	22	4.3	75
11.	Magnesium ”	29	6.80	30
12.	Sulphide ”	2.8	0.2	
13.	Bicarbonate ”	4.1	ND	
14.	Phosphate ”	3.2	0.95	
15.	Chloride ”	7985	79.12	250
16.	Dissolved oxygen ”	2.5	6.18	
17.	Dissolved carbon-di-oxide ”	41.2	9.65	
18.	Biologicaloxygen demand ”	56	14.95	
19.	Chemical oxygen demand ”	390	23.1	
20.	Total Chromium ”	0.009	ND	

All the values are averages of for tnight sampling for six months
*Bureau of Indian standards. ND-Not detectable

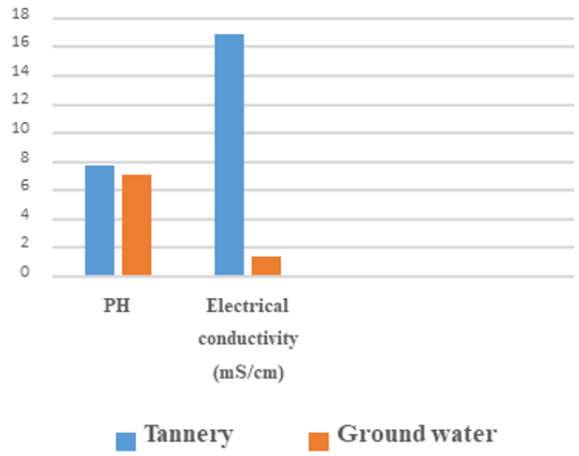

Figure 1: Physical characteristics of water samples

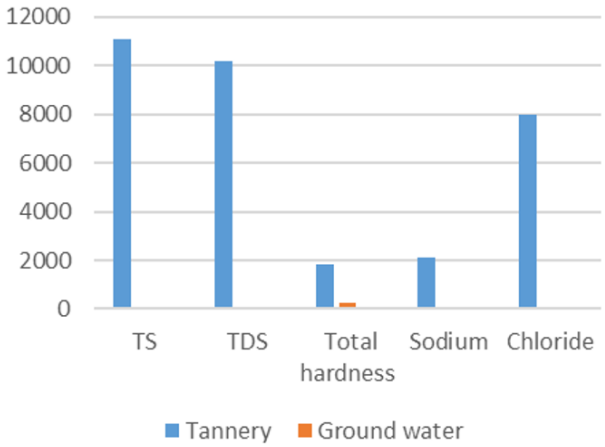

Figure 2: Chemical characteristics of water samples

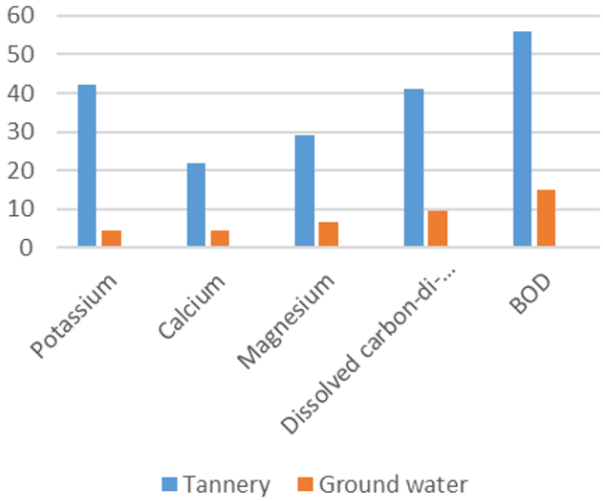

Figure 3: Chemical characteristics of water samples

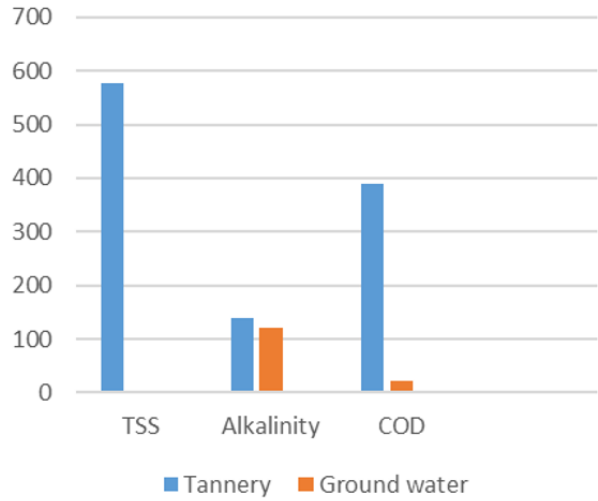

Figure 4: Chemical characteristics of water samples

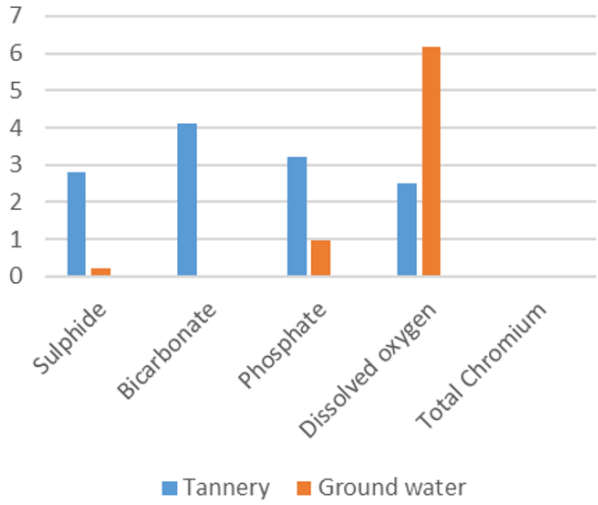

Figure 5: Chemical characteristics of water samples

hides. The tannery soil have very high values of (ESP) and the Sodium Adsorption Ratio (SAR) (Table 5). (Figures 6, 7, 8, 9 and 10).

A complete range of pollutants viz., chemical and physical have been in charge of deterioration of physical and chemical properties of water because of urbanization, industrialization and new innovative technologies. Most of the environmental contamination studies are basically worried about water and soil contamination. The quantity of unpolluted water level is going to an end. There is solid proof of the dynamic disintegration of water quality in our nation as well as everywhere throughout the world (Sivakumar, 1977).

Rapid industrialization growth in our country has brought about impressive increment in the fluid waste which is ordinarily released into open land

Table 5: Physico-chemical characteristics of soil samples

S.No	Parameters	Tannery soil (Polluted)	Garden soil (Unpolluted)
1.	PH	8.6±0.21	7.4 ± 0.6
2.	Electrical conductivity (mS/cm)	17.5±0.19	1.94±0.01
3.	Moisture content (%)	4.12±0.15	5.75 ±0.53
4.	Hardness (mg/g)	2080± 0.64	790 ±0.35
5.	Organic matter (%)	0.35± 0.44	7.2 ±0.11
6.	Nitrogen (available)	50.0 ±0.25	89 ±0.19
7.	Phosphorus (available)	5.5 ±0.52	12.0±0.49
8.	Potassium (available)	105 ± 1.12	225 ±0.25
9.	Sodium (ppm)	190 ±1.12	50 ±0.14
10.	Calcium (ppm)	171 ±1.42	42 ±0.71
11.	Chloride (ppm)	30± 0.91	5.58 ±0.49
12.	Zinc (ppm)	4.65 ± 0.96	3.10 ±0.65
13.	Iron (ppm)	13.45 ±0.46	3.40 ±1.25
14.	Manganese (ppm)	11.05 ± 0.51	7.45 ±0.26
15.	Copper (ppm)	2.90± 0.21	2.20 ±0.89
16.	Magnesium (ppm)	12.10 ± 0.21	4.10 ±0.71
17.	Sodium adsorption ratio	26.45 ± 0.45	12.50 ±0.16
18.	Exchangeable sodium percentage	28 ±0.21	13.8 ±0.54

All the values are averages (mean ± S.D) of 5observations (CFU) – Colony Forming Unit

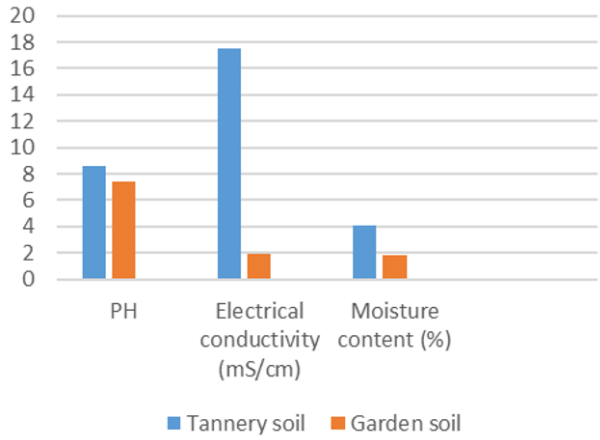

Figure 6: Physical characteristics of soil samples

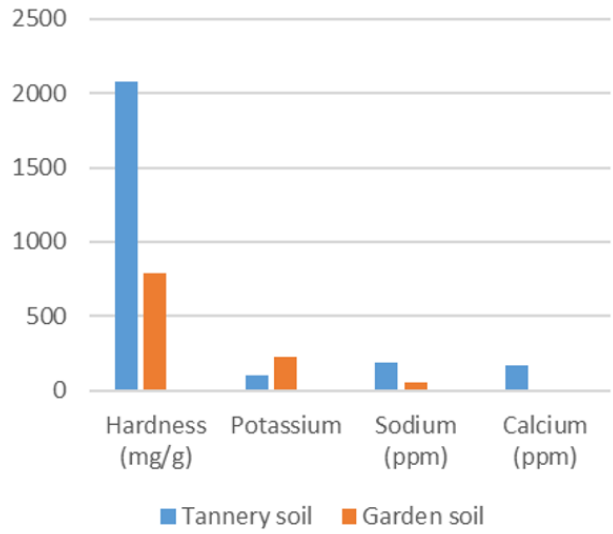

Figure 7: Chemical characteristics of soil samples

or into close by water bodies, causing gigantic natural pollution. Tannery wastewater are positioned as potential pollutants among every single industrial waste Eye and Liu (1971). The salts of the released effluent discover their way into water system repositories, polluting the water by a waterway reaching out from the industries to the reservoir mouth, extending for separation of around 5 kilometres. Tannery wastewater likewise contains tremendous measures of organic and inorganic mixes, which are dangerous to aquatic plants or living organisms (Banerjea and Motwani, 1960). Rajagopalan and Davies (1967) reported that the productivity of soil diminished when tannery wastewater was connected and the horticulture land wound up not appropriate for farming. Ahamed *et al.* (1977) studied the contamination impact of tannery wastewater and revealed that the salts in tannery wastewater release through the dirt, along these lines causing high-value saltiness of the land. In and around 324 hectares of agriculture land in Dindigul district have

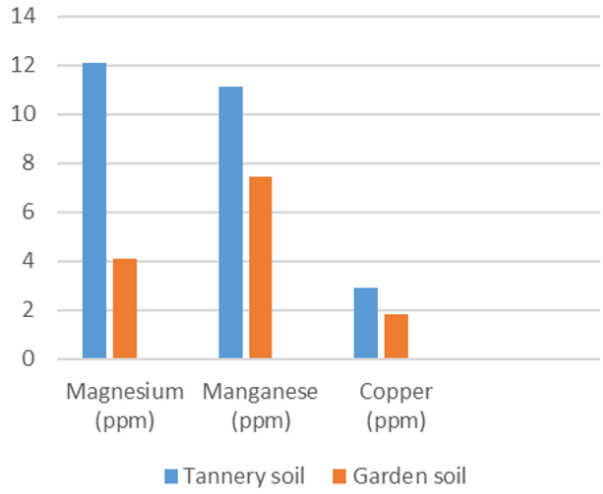

Figure 8: Chemical characteristics of soil samples

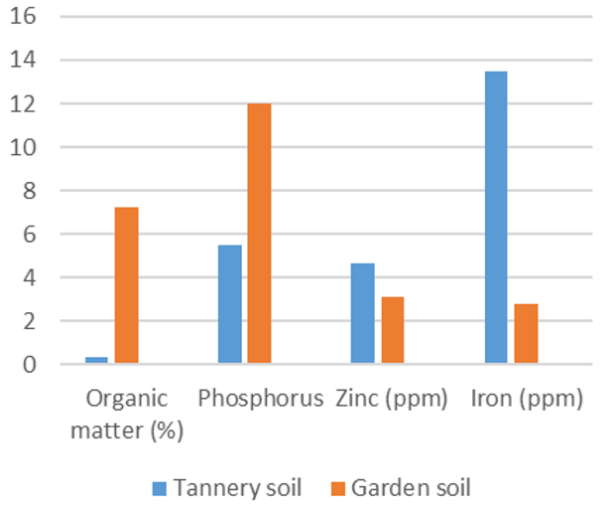

Figure 9: Chemical characteristics of soil samples

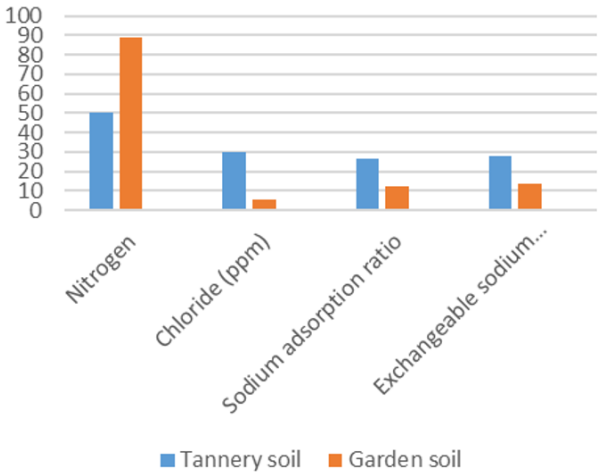

Figure 10: Chemical characteristics of soil samples

been genuinely harm because of tannery wastewater and ripe land has now turned out to be not suitable for agriculture farming (Baskar, 1992). Jogdan (1995) reported that the 2161cottage industries which are process about 5,00,000 tons of skins and hides annually. About12140 hectares of land was moderately damaged in Dindigul, Ambur, Vellore, Vishram, Vaniyambadi, Ranipet, and Timur township territories and 4000 hectares of farming land was seriously damaged by the tanneries of North Arcot District (Sastry, 1980).

Alexander (1961) observed that the plant's root system have caused nitrogen uptake is reduced because of tannery effluents. The results of the present study on the chemical and physical characteristics of tannery wastewater are discussed hereunder. The tannery wastewater contains high values of EC, TDS, anions and cations. The high values of chloride, sulphate and sodium, present in the effluent interferes with and inhibit the uptake of other elements by the plants.

During the tanning process, the tanneries use a number of chemicals, viz. Lime, chloride, sodium, sodium bicarbonate sodium carbonate, sodium sulphide, ammonium sulphate, sulphuric acid, chromium sulphate, ammonium chloride, oxalic acid, fat, liquors and dyes Apparao and Karthikeyan (1990). The organic impurities in tannery wastewater are the cause for its bad odour. The use of salts during the processing of leather (soaking, picking and liming) increases the hardness of the tannery effluent. Composite tannery effluent has a high value of chloride. When it is thoroughly discharged into a river, it seriously affects the quality of the water. ChromiumandArsenic renders the water not suitable for domestic uses and drinking (Trivedi and Raj, 1992). The authors also pointed out that the discharge of tannery effluents on land would adversely affect the groundwater quality due to the presence of excessive amounts of chlorides, chromium, boron and arsenic.

The major pollutants in tannery wastewater are a high value of TDS, sulphate and chlorides. Besides, vegetable tannery wastewater is highly coloured while chrome tannery effluent is highly toxic Observed high pH, EC, hardness, sodium, chloride, anions and cations in the present study coincide with these findings. The Water Quality Index was observed to be very high. Hence, it is concluded that the extent of pollution of this wastewater sample was well above the BIS (Bureau of Indian Standards) permissible limit and it was not at all suitable for any use by human beings.

The analysis results of the chemical and physical

characteristics of polluted soil (tannery soil) with reference to garden soil are discussed below. Tannery soil was analysed and was found to have high values of EC, sodium, chloride, micronutrients and macronutrients and low values of organic matter. Higher concentrations of sodium and chloride in the soil inhibit the uptake of other ions from the soil by plants. The chemical and physical characteristics such as EC and pH of the tannery-polluted soil was usually high because of the addition of lime, caustic soda, common salt and other chemicals during the tanning process. The soil PH is dependent on Exchangeable Sodium Percentage (ESP). So higher the ESP, the more will be the PH. Alkali soils have low permeability due to which air and water movement is reduced.

The nitrogen and phosphorus availability decreased in the tannery effluent affected the soil. This reduction caused the withering of maize (Raniperumal, 1996). Further, it was observed that in the tannery effluent affected soil, chloride, sodium, calcium, manganese, iron, zinc and magnesium were higher when compared to those in the garden soil, and it was due to the addition of various chemicals during the processing of hides (Baskar, 1992; Apparao and Karthikeyan, 1990). The electrical conductivity of the soil also increased considerably, and this is due to the deposit of salts in the soil with the addition of tannery effluent. Salt affected soil, due to its excessive salt content and high sodicity results in slightly adversely physical condition of soil, low and unstable nutrient availability (Baskar, 1992). Raniperumal (1996) reported that, when tannery effluent is used for irrigating crop plants, the salts in the effluent get accumulated in the surface soil, which, in turn, affects the germination and yield of crops. Saline soils are characterized by the high osmotic pressure of soil solution. The presence of a high concentration of salts reduces the vegetative growth by increasing the osmotic pressure of soil solution, thus producing a physiological drought for the plants.

CONCLUSIONS

Nature is able to cope with certain amounts of waste, via a variety of natural cleaning mechanisms. The manufacturing of animal products for human utilization like meat and dairy products or for other human needs for leather drives unavoidably to the generation of wastewater. Under conventional conditions, the amounts of items prepared in a specific zone used to be small and by-products were better utilized. Normally, small scale home handling activities produce generally limited quantities of waste and wastewater. The high concentrations of TSS, TDS, BOD, COD, salt and oil and grease in tannery waste water influences the nature of water and may cause terrible taste and odour. Materials like lime, hair, fleshing's made the surface water turbid and settles in the end on the base. A superior methodology than the customary strategies is to totally destroy the pollutants if conceivable, or possibly to change them to harmless substances. Bioremediation is a choice that offers the possibility to pulverize or render different innocuous contaminants of tannery wastewater at Tiruchirappalli district utilizing regular natural action

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REFERENCES

Ahamed, L. N., Basker, S., Rengaswamy, G. 1977. Pollution effects on tannery waste-two case studies. Leather Sci, 24:416–422.

Alexander, M. 1961. *Introduction to soil microbiology*. Wiley and Sons, I.N.C., New York.

Apha 1990. *Standard Methods for the Examination of Water and Wastewater*, volume Water Environment Federation of *Standard Methods*. American Water Works Association, Washington DC, 20 edition .

Apparao, B. V., Karthikeyan, G. 1990. *Pollution due to tanneries ol'Dindigul*. Gandhigram Rural Institute-Gandhigram, Dindigul.

Banerjea, S., Motwani, M. P. 1960. Some observations on pollution of the suv aon stream by the effluents of a sugar factory, balrampur (up). Indian Journal of Fisheries, 7(1).

Baskar, J. P. 1992. Devastation by leather tanneries in Tamil Nadu. Development in Practice, 2(2):127–129.

Eye, J., Liu, L. 1971. Treatment of Wastes from a Sole Leather Tannery. Journal Water Pollution Control Federation, 43(11):2291–2303.

Jackson, E., Farrington, D. S., Henderson, K. 1986. *(MAFF) Ministry of Agriculture. Fisheries and food. The Analysis of Agricultural Materials: A Manual of the Analytical Methods Used by the Agricultural Development and Advisory Service*, volume 427. Great Britain, 3 edition .

Jackson, M. L. 1973. *Soil Chemical Analysis*. Scientific Research Publishing, New Delhi, 498.

Jogdan, S. 1995. Tannery industry and biotechnology. Environmental Biotechnology, pages 161–168.

Lindsay, W. L., Norvell, W. A. 1978. Development of a DTPA Soil Test for Zinc, Iron, Manganese, and Copper1. Soil Science Society of America Journal, 42(3):421–421.

Mcgeorge, W. T. 1954. Diagnosis and Improvement of Saline and Alkaline Soils. Soil Science Society of America Journal, 18(3).

Natusch, D., Hopke, P. K. 1983. Analytical aspects of environmental chemistry. In *Chemical Analysis: A Series of Monographs on Analytical Chemistry and Its Applications*, pages 34–38, New York. John Wiley and Sons.

Panse, V. G., Sukhatme, P. V. 1967. *Statistical Methods for Agricultural Workers*. Indian Council of Agricultural Research, New Delhi.

Piper, A. M. 1944. A graphic procedure in the geochemical interpretation of water-analyses. Transactions, 25(6).

Rajagopalan, R., Davies, N. H. 1967. Tannery water used for agricultural purposes. Indian J Environ Protect, 16:154–157.

Raniperumal, P. S. 1996. Chemical of soil and irrigation water by tannery effluent Tamil Nadu experience. Indian Jr. Agri. Chem, 1:1–8.

Sastry, C. A. 1980. Sources effects and treatment of Waste water from tanneries. In *Proc.sym. Tannery wastes. Central Leather Research Institute*, pages 241–241.

Sivakumar, M. 1977. Quality of well waters in Madurai. Indian Journal of Environmental Health, 19(93):199–199.

Steel, R. G., Torrie, J. H. 1960. *Principles of procedure-sof statistics*. New York.

Trivedi, P. R., Raj, G. 1992. Pollution control, treatment and disposal of tannery wastes. In *Akashdeep publishing House*.

Trivedy, R. K., Goel, P. K. 1984. Chemical and biological methods for water Pollution studies. Environmental Research, pages 72–76.