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Assessment of Tannery Effluent and Soil Sediment of Common Effluent Outlet Area, Dindigul District, Tamilnadu, India

Nazeema. M[1], Nirmala. T[2]
[1]Research Scholar, PG & Research Centre of Zoology, Jayaraj Annapackiam College for Women (Autonomous), Affiliated to Mother Teresa Women's University, Periyakulam, Tamil Nadu, India.
[2]Former Principal of Jay raj Annapackiam College for Women, Periyakulam
Principal of Annai Scholastica Arts and Science College Tharuvai Thoppu, Thangachimadam Ramanathapuram

Abstract— *The present investigation was undertaken to evaluate the physico-chemical properties of Tannery waste water of tannery effluent tank, Dindigul district. The results revealed that the tannery effluent was brown in colour, appeared with high solid content. All the physical and chemical parameters were high. Furthermore, soil also undergone for metal analysis and totally 11 elements were estimated. Among the eleven elements potassium, magnesium, lead, iron, zinc, cadmium, manganese and chromium were the dominant metals in both the soil samples. It may be dependent on physic chemical conditions such as pH, temperature and the presence of other ions in the soil samples.*

Keywords— *Tannery effluent, soil, phy-che analysis, Dindigul.*

I. INTRODUCTION

Leather is a popular product for luxury consumer goods. More than 2,200 ton leather per year is produced worldwide to make Belt, shoes, bag, watch strap, jacket, phone cover and wallet. The creation of every high quality leather product is a fascinating, ever evolving process that is not to be taken lightly. Tanneries are such industries which contributes a major part in water usage and sewage discharge. Obviously the wastewater effluent from this unit contains considerable amounts of hazardous pollutants, and where heavy metals are very common S. Krishnamoorthi and K. Saravanan (2011).

The tanning industry is one of the major consumers of water and most of it is discharged as waste water, which contains high amounts of heavy metals such as Fe, Cr, Zn, Mn, Cu etc. (Devi et al., 2011). The enormous pollution load along with the toxic nature of waste water makes the tanneries a potential threat to the areas in the vicinity of their location which when consumed causes serious health hazards (Panwar et al., 2002). Though tanneries are revenue and job generating sector, the pollution from their effluent is not taken complete care of which is the major concern. The objectionable constituents present in large amounts in the effluents are suspended solids, chlorides, sulfides, chromium, tannins and organic wastes.

For a long time, Dindigul town has been associated with Iron locks, Iron safe of good quality and durability. A lock manufacturing unit under co-operative sector is functioning here. Another industry for which Dindigul is noted is Leather tanning. Roughly 40 percent of the total tanneries of India are located in Tamil Nadu. Dindigul, is a medium size town near Gandhigram, is one of the centers where active tanning is carried out in more than 60 tanneries. In this area in and around tanneries were grouped into three categories such as big, medium and small. Those tanneries that process raw materials more than 4000 kg/day are in big size tanneries followed by 1500 to 4000 kg/day in medium size tanneries, and less than 1500 kg/day in small size tanneries (V.Anuradha 1999).

Tanning and finishing industry in India is concentrated in Madras, Ranipet, Amber, Vaniyambadi, Erode, Dindigul, Permabut, Agra, Calcutta, Maharashtra, West Bengal, Rajasthan, Punjab, Kanpur (Jajmau) and Unnao area of Uttar Pradesh (Vijayanand and Hempriya, 2014). Tannery industries consume a considerable amount of water in their manufacturing processes and serve as a major source of tanned and untanned solid waste and liquid effluents which contain high organic load, salts and chromium, releasing about 40-25,000 mg/L of chromium in their effluent (Obgonna et al., 2008).

This discharge of untreated wastewater in water courses affect the physical, chemical and biological characteristics of water and deplete the dissolved oxygen of the water bodies (Rajiv et al., 2012, Ladwani et al., 2012, Subin and Husna, 2013). Tannery wastewater encloses extensive amounts of perilous pollutants in which heavy metals are very common (Saranraj and Sujitha, 2013). According to Krishnamoorthi and Saravanan (2011), the heavy metals can create cancer, brain or kidney damage. One of the greatest environmental problems in the tanneries is the removal of chromium content as a byproduct. Tannery effluents mostly influence the ecosystem of the rivers and declines seeds germination in cultivable crops (Koizhaiganova et al., 2014). Pollution is the greatest threat posed to humanity and even to the whole biosphere (Shivakumar and Thippeswamy, 2012).

Soil is an important system of terrestrial ecosystem. There is a direct impact of pollutants on minerals, organic matter and microbial community of soil (Nagaraju et al., 2007). The discharge of industrial effluents especially without treatment may have profound influence on physico-chemical and biological properties of soil related to soil fertility. A wealth of information on occurrence of changes in properties of soils due to discharge of effluents from industries such as cotton ginning mill (Narasimha et al.,1999), sugar industry (Nagaraju

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et al., 2009), paper mill (Nilima and Madhuri, 2005), dairy industry (Nizamuddin et al.,2008), dairy wastewater (David shyam babu et al., 2010) are available.

The aim of this study is to assess the water and soil properties and their impact on the whole environment of the industrial area where the main tannery outlet is situated at Begambur area, Dindigul.

II. METHODOLOGY

2.1 Physico-chemical analysis of effluent:

Industrial effluent was collected in polythene containers from an outlet of the industry located in Dindigul, Tamil nadu, India, were brought to the laboratory, and stored for further analysis. The physico-chemical parameters of the effluent - pH, Electrical Conductivity (EC), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Total Hardness, Chloride, Sodium, Calcium and heavy metals were estimated by following the Standard methods suggested by APHA (1995).

Effluent soil samples were collected in fresh polythene bags for further analysis.

2.2 Metals in Effluent Water

Suitable volume of sample was taken, filtered through Whatmann 42 filter paper and then acidified with concentrated HNO3 to bring down the pH up to 2.0. 100 ml of sample was taken and added 5 ml concentrated HNO3, and then digested in a closed chamber, within 30 minutes digestion was completed and make up the volume to 100 ml with distilled water. Digested samples were analyzed for metal concentrations by Atomic Absorption Spectrophotometer (Perkin Elmer 3110). The Cr (VI) concentrations in samples were determined calorimetrically by using spectrophotometer at 540 nm by Diphenyl Carbazide (DPC) method (APHA, 1998).

2.3 Metals in Soil

0.25 gm soil was digested with 10 ml Hydro fluric acid and 1 ml aquaregia i.e. HCl and HNO3 in a ratio of 3:1 in a flask. Thereafter, 5.0 ml of HClO4 was added and again heated on heating plate up to dryness and double distilled water was added to make up the volume to 100 ml and filtered through Whatman no. 42 filter paper. Digested soil sample were analyzed for metal concentrations by Atomic Absorption Spectrophotometer (Berrow and Mitchell, 1993; Buckley and Cranston, 1993).

III. RESULTS AND DISCUSSION

The physicochemical parameters of the effluents were analyzed (Table 1). The result of the study revealed that colour of the untreated effluent was blackish or brown in colour with offensive odour. Similar results were reported by Noorjahan (2014) for the untreated tannery effluent. A large number of pollutants can impart colour, taste and odor to the receiving water, thereby making them unaesthetic and unfit for domestic consumption (Jamal et al., 2011). Slightly brownish but the odour was similar to that of the untreated. Brown colour of the tannery effluent was also reported by Smrithi and Usha (2012) and Singh et al. (1998). The colour of the effluent might be due to the presence of biodegradable and non-biodegradable high molecular weight organic compounds and high amount of inorganic chemicals like sodium and chromium used during the processing and the odour may be due to putrefaction of the organic residues from the processed skin and hides.

Table 1: Physico Chemical Examination of Water Sample from Tannery Effluent Tank during 2018

S.No	Physical Examination			
	Description	**Acceptable Limit (mg/l) WHO (2012)**	**Exceeding Limit (mg/l)**	**Tannery water in Dindigul (mg/l)**
1	Appearance	-	-	Brownish
2	Turbidity	2.5	10	740
3	Electrical Conductivity Micro mho/cm	-	-	16, 100
4	Total Dissolved Solids mg/l	500	2000	11,200
Chemical Examination				
1	Alkalinity as CaCo3	-	-	880
2	PH	7.0 – 8.5	6.5 – 9.2	7.6
3	Total Hardness	200	600	2700
4	Calcium as Ca	75	200	640
5	Magnesium as Mg	30	150	270
6	Iron as Fe	0.1	1.0	1.0
7	Manganese as Mn	0.05	0.5	0.1
8	Ammonia as NH3	-	-	12
9	Nitrate as NO3	100	100	40
10	Nitrite as NO2	-	-	0.5
11	Fluoride as F	1	1.5	0.4
12	Biological Oxygen Demand	-	-	550
13	Chloride as Cl	200	1000	4754
14	Dissolved Oxygen	-	-	1
15	Sulphate as SO4	200	400	400
16	Phosphate as PO4	-	-	0.5
17	Tidys Test (4hours) as O2	-	-	5
18	Chemical Oxygen Demand	-	-	1500
19	Chromium as Cr	0.05	0.1	245

PH of the tannery effluent was found to be alkaline. Discharge of such effluent with alkaline pH into ponds, rivers, etc for irrigation may be detrimental to aquatic biota such as zooplankton and fishes. According to Saxena and Shrivastava (2002), alkaline nature of the tannery effluent may be due to the presence of carbonates and bicarbonates present in the effluent. Untreated effluent showed higher level of Electrical conductivity (8344-9138 µmhos/ cm) which could reflect the presence of organic and inorganic substances and salts that would have increased the conductivity (Marwaha et al., 1998). It may be due to high concentration of acid base and salt in the effluent (Jamal et al., 2011).

Turbidity and Electrical Conductivity (EC) was found to be 740 and EC 16,100 (Table 1) which is lowest than the study of Jahan et al. (2014). In this study TDS was measured as 11,200 mg / l which is beyond the permissible limits. Total Dissolved Solids (TDS) is the measure of total inorganic salts and other substances that are dissolved in water (Nasrullah et

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al. 2006). High levels of TDS are aesthetically unsatisfactory and may also produce distress in human and livestock (Patel et al., 2009). Total dissolved solids are mainly due to carbonates, bicarbonates, chlorides, sulphates, phosphates, nitrates, nitrogen, calcium, sodium, potassium and iron (Kannan et al., 2009). Noorjahan (2014) reported TDS value as 5758 - 6672 mg/L. The presence of high level of TSS and TDS may be due to the insoluble organic and inorganic present in the effluent (Nagarajan et al., 2005).

Tannery wastewater is characterized mainly by measurements of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), suspended solids (SS) and Total Dissolved Solids (TDS), chromium and sulfides etc. (Gower, 1980). The permissible limits for parameters in the wastewater from an industrial establishment mentioned in the rightmost column are stipulated by World Health Organization (WHO, 2012). Among the parameters, Total Dissolved Solid (TDS) were found high. pH and temperature of the wastewater were also recorded as higher than the permissible limit.

The results of present study revealed that chloride level 4754 mg /l and the levels exceed the permissible chloride level of 1000 mg/L of effluent discharge into inland surface waters. High levels of chlorides in the tannery effluent could be attributed to the soaking and pickling processes. The chloride content in water sample gives an idea of the salinity of water. According to (Rouf et al., 2013) the increased amount of chloride enhances the acidity of water.

Nitrate and fluoride was recorded as 40 mg/l and 0.4 respectively which was lower than the standard values. The major trouble of Nitrogen compounds released to the environment is burning up dissolved oxygen in water (Alavi et al, 2013).

The permissible value of chromium will be 1.47 mg/l but in the present study it was estimated very high as 241 mg /l. The chrome tanning process originates toxic metals and regular treatment systems are not eligible for the elimination of the metals (Saritha and Meikandaan, 2013). Chromium infectivity gets significance for its severe lethal behavior at a lessen concentration (Abinaya et al., 2015). Chromium (VI) is a widespread noxious waste can be formed easily by the tannery effluents which are not processed. The toxicity of Chromium (VI) is 500 times higher than Cr (III) (Kushwaha and Kanjan, 2015). It is carcinogenic and restrains enzymes and nucleic acid production of biological process by Anandbabu and Yogamoorthi (2014).

Chlorides are introduced into tannery effluents as sodium chloride usually and it is ranged as 4754 mg/l which is higher than the permissible limit, may be due to the large quantities of common salt used in hide and skin preservation or the pickling process. Being highly soluble and stable, they are unaffected by effluent treatment and nature, thus remaining as a burden on the environment. Chlorides inhibit the growth of plants, bacteria and fish in surface waters; high levels can lead to breakdowns in cell structure. If the water is used for irrigation purposes, surface salinity increases through evaporation and crop yields fall. When flushed from the soil by rain, chlorides reenter the ecosystem and may ultimately end up in the ground water. High salt contents are only tolerable if the effluents are discharged into tidal/marine environments (Bosnic et al., 2000, karabay 2008, Buljan et al., 2011). Rasmussen (2000) reported that the use of huge salts in different stages of tanning process which was the reason for high concentrations of sodium and chloride in the effluent. Kolay (2000) studied that the high amount of sodium in water breaks the soil aggregates and blocks the soil pores in irrigated fields.

Varadharajan et al. (1970) analyzed and reported tannery effluent that the presence of considerable amount of chlorides, carbonates, bicarbonates, sulphate, sodium and magnesium which will pollute the land. Baskaran (1977) also reported the arsenic; chloride and chromium that are present in tannery effluent would render the water unsuitable for drinking and lead to heavy chloride pollution in well water. Ahamed et al., (1977) conducted a survey of the tannery affected areas of North Arcot district and observed that the total soluble salt and chloride values of surface water in the river at Vaniyambadi were about 2000 and 800mg/l respectively. Sastry (1981) reported that organic pollutant like chloride, trivalent chromium, nitrogen, sulphate and lime were present in significant quantities in tannery effluent and it also contains high amount of ammonia, which affects the soil as well as water quality which coincide with the findings of the present study.

Soil results

The results of the physico-chemical parameters of the soil samples determined were presented in (Table 2). For this study, control soil sample was collected 10 km away from the tannery area and the effluent soil was collected at the study area.

Table 2: Parameters recorded in control and tannery effluent contaminated soil

Parameters	Control soil sample	Effluent contaminated soil sample
pH	7.1	8.30
EC mho/cm	0.48	0.52
Sodium (mg/kg)	125	138
Potassium (mg/kg)	345	468.5
Phosphorous (mg/kg)	45	95
Copper (mg/kg)	23.3	48.12
Magnesium (mg/kg)	18.45	59.67
Lead (mg/kg)	9.4	20
Iron (mg/kg)	10.12	11.4
Zinc (mg/kg)	21	44
Cadmium (mg/kg)	11	13.5
Manganese (mg/kg)	35	44.6
Chromium (mg/kg)	39.9	57.6

Tannery effluent samples varied widely in terms of their pH and electrical conductivity (Table 2) and the increase may be due to the use of different chemicals at various stages of leather manufacturing processes were done. The respective range of pH and EC was being changed for control and the effluent contaminated soil samples between 7.1 and 8.30; and 0.48 and 0.52 ms/cm. The data shows that all the elements were high as compared to the control soil samples. Among the eleven elements potassium, magnesium, lead, iron, zinc, cadmium, manganese and chromium were the dominant metals in both the soil samples. It may be dependent on physic

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chemical conditions such as pH, temperature and the presence of other ions in the soil samples (Saadia et al., 2006).

High levels of these elements are observed in control soil sample because of subsoil penetration of the tannery industry and could be the industrial effluent impact on the soil sample. Therefore sodium among the macronutrients ranges from 125 to 138 and chromium among the heavy metals ranges from 39.9 to 57.6 were found to be a highest values and the same report was given by (Zeshan Ali et al., 2013).

In the study area lead amount was little higher than the permissible limit and Tosic et al.,(2015) studied high amount of lead concentration is one of the most abundant and wide spread contaminations, and lead accumulation in human body is due to the environmental exposure factors (Amirabadi et al., 2016).

Next to lead, cadmium is a trace element that was found high in industrial sites and it ranges from 11 to 13.5 and the contamination is due to anthropogenic impact as reported by Akbar et al., (2012). Cadmium and lead are known as toxins and carcinogens (Rajaganapathy et al., 2011).Thus in the present study, heavy metals observed in the soil was higher than the maximum permissible limits.

IV. CONCLUSION

The tannery effluent was brown in colour, appeared with high solid content. Turbidity and electrical conductivity of the water was high when compared to the surface water. Total dissolved solid content in the effluent was very high. Chemical examination of the effluent showed high BOD and COD with slight alkalinity. Calcium and magnesium of the effluent was considerably high which increases the hardness of the water. Chromium in the effluent was significantly high when compared to the normal standard level. The level of nitrate is in tannery effluent exceeds beyond the normal level which is the main reason for eutrophication. In the soil all the metals both in control and effluent contaminated soil were extremely high which is highly polluted due to the presence of tannery effluent.

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