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PHYSICO-CHEMICAL CHARACTERISTICS OF UNTREATED EFFLUENT FROM TANNERY INDUSTRIES IN TAMIL NADU: A COMPARATIVE STUDY

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ABSTRACT

The Physico-chemical characteristics of tannery effluents from four different stations, Ambur(latitude of 12.78°N and the longitude of 78.7°E); Vaniyambadi (78°-35° and 78°–38° North latitude and 12°–42° East longitude); Dindigul (latitude of 10.35°N and the longitude of 77.95°E); Ranipet (latitude of 12.942°N and the longitude of 79.323°E) were compared. In stations other than I and III the effluents were alkaline. In station I, the TDS, BOD and COD were comparatively higher. The effluent collected from station I differed significantly from the effluent collected from other stations with reference to the different physico-chemical characteristics based on Tukey Comparision.

KEY WORDS : **Tannery effluents, BOD, COD, Dissolved Oxygen, Chromium**

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INTRODUCTION

The wastewaters from the industries and domestic areas affect the water quality by their coloured nature, high organic content, widely varying pH, presence of heavy metals and other pollutants[1]. The raw tannery effluent causes serious damage to soil and water bodies. With the rapid growth of industries in the country, pollution of natural water from industrial waste has increased tremendously[2]. The tannery operation converts the raw hide or skin into leather and the processes involved make it a potentially pollution intensive industry. Tannery effluents, physical, chemical and biological properties of aquatic environment containing heavy metals, toxic chemicals, chloride, lime with high dissolved and suspended salts and other pollutants[3]. Tanneries generate wastewater in the range of 30-35L / Kg skin / hide processed with variable pH and high concentrations of suspended solids, BOD, COD, tannins and heavy metals like chromium[4]. The present paper is based on a comparison of tannery effluent samples collected from four different stations in Dindigul (Dindigul) and Vellore (Ambur, Vaniyambadi, Ranipet) districts of Tamil Nadu, where the tannery effluent is damaging the local environment.

MATERIALS AND METHODS

For the present study, raw tannery effluent samples were collected from four stations, situated in Ambur (latitude of 12.78^{o}N and the longitude of 78.7^{o}E), Vaniyambadi (78^{o}-35^{o} and 78^{o}–38^{o} North latitude and 12^{o}–42^{o} East longitude), Ranipet (latitude of 12.942^{0}N and the longitude of 79.323^{0}E) and Dindigul (latitude of 10.35^{0}N and the longitude of 77.95^{0}E) in Tamil Nadu. The raw effluent samples were directly collected from the outlet of the tanneries in plastic containers. The physico-chemical parameters were estimated using standard methods[5].

RESULTS AND DISCUSSION

The results of the physico-chemical characteristics of four station tannery effluents were analyzed in the laboratory for the parameters such as colour, pH, Total Dissolved Solids (TDS), Electrical Conductivity(EC), Total Hardness, Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Chlorides, Chromium, Calcium, Magnesium, Nitrate, Sulphates and Dissolved oxygen were given in Table - 1. The colour of the tannery effluent from all the four stations was brown/darkish brown with unpleasant odour. Tannery wastewaters are basic, have a dark brown colour and have a high content of organic substances that vary according to the chemicals used[6]. The colour is usually the first contaminant to be recognized in wastewaters that affects the aesthetics, water transparency and gas solubility of water bodies[7]. A large number of pollutants can impart colour, taste and odour to the receiving water, thereby making them unaesthetic and unfit for domestic consumption[8]. The pH was found acidic (3.84 ± 0.09) for samples collected from Ambur tannery and (6.3 ± 0.32) for samples collected from Dindigul tannery while it was slightly alkaline for samples of Vaniyambadi(8.2 ± 0.33) and Ranipet tannery (7.9 ± 0.52, Table 1). The pH difference is statistically significant between stations I and III where as stations II and IV do not vary significantly. Other workers also reported acidic[9,10] and alkaline tannery wastewaters[11,12,13,14].

Table 1
Physico-chemical properties of untreated tannery effluents collected from four stations

Characteristics	Station - I Ambur	Station - II Vaniyambadi	Station - III Dindigul	Station - IV Ranipet
Colour	Dark Brown	Brown	Dark Brown	Dark Brown
pH	3.84 ± 0.09^a	8.2 ± 0.33^b	6.3 ± 0.32^c	7.9 ± 0.52^b
Electrical Conductivity (µs/cm, 25°C)	27.4 ± 0.41^a	34.7 ± 1.15^b	26.8 ± 0.43^a	40.2 ± 0.64^d
Total Dissolved solids (mg/l)	26470 ± 397^a	13206 ± 202^b	18651 ± 282^c	14785 ± 211^d
Total Hardness(mg/l)	1820 ± 26.11^a	1512 ± 20.82^b	2413 ± 27.03^c	1630 ± 1.93^d
BOD (mg/l)	3230 ± 29.92^a	1311 ± 24.13^b	2420 ± 24.66^c	1957 ± 9.62^d
COD (mg/l)	11770 ± 137.56^a	4050 ± 56.46^b	5700 ± 48.47^c	6820 ± 8.92^d
Magnesium (mg/l)	830 ± 15^a	268 ± 5^b	390 ± 15^c	420 ± 12^d
Calcium (mg/l)	990 ± 15.81^a	270 ± 6.56^b	594 ± 6.29^c	516 ± 3.39^d
Chlorides (mg/l)	2950 ± 55^a	572 ± 6^a	7135 ± 80^c	862 ± 17^d
Sulphates (mg/l)	16300 ± 79.3^a	430 ± 4.74^b	981 ± 5.79^c	376 ± 3.8^b
Nitrate (mg/l)	116 ± 4.18^a	48 ± 2.91^b	46 ± 2.24^b	345 ± 10.1^d
Chromium (mg/l)	140 ± 4^a	19.5 ± 0.3^b	131 ± 3.4^c	48.2 ± 0.64^d
Dissolved oxygen(ml/l)	6.06 ± 0.04^a	2.69 ± 0.03^b	1.74 ± 0.04^c	1.92 ± 0.02^d

Means within a column followed by the same letter are not significantly different from each other according to Tukey HSD ($p \leq 0.01$)

The Electrical Conductivity of Dindigul samples (26.8 ± 0.43 µs/cm) was lower than that for other three station samples (27.4 ± 0.41, 34.7 ± 1.15, 40.2 ± 0.64 µs/cm, Table-I), being too high in comparison to the treated effluent conductivity (14.44 ms/cm)[15]. The Electrical Conductivity difference is statistically significant between stations II and IV where as stations I and III do not vary significantly. Increase in Electrical Conductivity values indicates presence of higher concentrations of ions. In the present investigation higher mean value of Total Dissolved Solids(TDS) was measured in Ambur tannery effluent (26470 ± 397 mg/l) and a minimum of (13206 ± 202 mg/l) at Vaniyambadi (station – II, Table - 1). The TDS difference is statistically significant between all the four stations based on Anova and Tukey comparisons. Other workers also reported large fluctuations in total solids (8000 - 76,500 mg/l)[13,9,11,16.17]. The high amount of total dissolved solids-recorded in the tannery effluent could be attributed to processes like soaking, liming, dehairing, defleshing and deliming[18]. The Biochemical Oxygen Demand (BOD) levels ranged between a minimum (1311 ± 24.13 mg/l) in (station-II) Vaniyambadi tannery samples and to a maximum of (3230 ± 29.92 mg/l) in Ambur tannery samples (station-I, Table 1). The BOD difference is statistically significant between all the four stations based on Anova and Tukey comparisons. Other workers also made similar observations[13,11,19] and found exceptionally lower value (600 mg/l)[15]. The high BOD and low oxygen content of tannery wastewater will affect survival of gill breathing animals of the receiving water body[20] . Present investigation is in agreement with the studies on tannery effluent[21]. The Chemical Oxygen Demand (COD) levels ranged between a minimum (4050 ± 56.46 mg/l) in (station-II) Vaniyambadi tannery samples and to a maximum of (11770 ± 137.56 mg/l) in Ambur tannery samples (station-I) and the other two station ranges of tannery effluent are shown in Table -1. This indicates that the effluent is unsuitable for the existence of the aquatic organisms, due to the reduction in the dissolved oxygen content[22]. A large variation in COD values of the tannery wastewaters had been reported in literature (1916 - 27,810 mg/l)[23,11,24,15]. Further high COD may be due to high amount of inorganic compounds which were not affected by the

bacterial decomposition[25]. In the present study high level of COD was recorded and these values did not meet the standard prescribed by Central Pollution Control Board (CPCB, 1995) for effluent discharge into inland surface water. The COD difference is statistically significant between all the four stations based on Anova and Tukey comparisons. The water is very hard if the Total Hardness value is beyond 180 mg/l[26]. In the present study the Total Hardness value ranges between a minimum in Vaniyambadi tannery samples((1512 ± 50 mg/l, station-II) and to a maximum of in Ambur (1820 ± 62 mg/l) tannery samples (station-I, Table-1). The Total Hardness difference is statistically significant between all the four stations based on Anova and Tukey comparisons. Levels of Chloride in the tannery effluents collected from four stations are shown in Table-1 and the chloride levels ranged between a minimum in Vaniyambadi (572 ± 6 mg/l, station-II) and to a maximum in Dindigul (7135 ± 80 mg/l, station-III). The Chloride difference in all the four stations is statistically significant. The chloride contents in tannery effluents were higher (2020.7 - 4313.0 mg/l, as also reported by other workers [9,14]. High levels of chlorides in the tannery effluent could be attributed to the soaking process involved[27] The Sulphate level ranged between a minimum (376 ± 3.8 mg/l) in Ranipet (Station– IV) and to a maximum(16300 ± 79.3 mg/l) in Ambur (Station-I). Levels of Nitrate in the tannery effluents of the four stations are depicted in Table-1. The Sulphate difference is statistically significant between stations I and III where as stations II and IV do not vary significantly. The Nitrate level ranged between a minimum of (46 ± 2.24 mg/l) in Station–III (Dindigul) and to a maximum of (116 ± 4.18 mg/l) in Station-I (Ambur). The Nitrate difference is statistically significant between stations I and IV, whereas stations II and III do not vary significantly. The Nitrate level range is 4.6 mg/l in the samples of Sansarpur village[28]. According to EPA (2002) permissible limits of nitrate in wastewater for discharge on land should be less than 10 mg/l as high concentrations of nitrates can cause serious health problems, when used for various purposes such as irrigation or drinking purposes. The mean values of Magnesium were higher (830 ± 15 mg/l) in Ambur tannery samples (Station –I) and lower (268 ± 5 mg/l) in Vaniyambadi tannery effluent samples (Station-II, Table-1). Levels of calcium in the tannery effluents of the four stations are depicted in Table -1 and Calcium level ranged between a minimum of (270 ± 6.56 mg/l) in Station– II (Vaniyambadi) and to a maximum of Station-I (Ambur, 990 ± 15.81 mg/l). The Magnesium and Calcium differences are statistically significant between all the four stations based on Anova and Tukey comparisons. The presence of calcium, magnesium and bicarbonates in excess make water unfit for irrigation since its application increase problems of soil salinity and its permeability detrimental to crop plants[29]. Dissolved oxygen (DO), the most important parameter of water quality, was maximum found (2.69 ± 0.03 mg/l) in Station– II (Vaniyambadi) and a minimum (1.06 ± 0.04 mg/l) in Station– I (Ambur, Table-1). In the present investigation, high level of Chromium was recorded (140 ± 4 mg/l) in Ambur tannery and a minimum (19.5 ± 0.3 mg/l) in Vaniyambadi tannery(Table-1) and these values did not meet the standard prescribed by CPCB (1995) for effluent discharge into inland surface water (permissible chromium level 0.06 mg/1). The Chromium difference is statistically significant between all the four stations based on Anova and Tukey comparisons. Among all the four stations, Ambur (station –I) showed higher range of physico-chemical parameters due to the large amount of chemicals used in the tanning process in the tanneries. Leather industries use about seventeen different kinds of tanning substances, but chromium is the most commonly used tanning agent[30]. Nearly 90% of all leather produced is tanned using chromium. TDS, Total Hardness, BOD, COD, Magnesium, Calcium, Chlorides, Chromium and Dissolved Oxygen of effluent samples collected from the four stations significantly differed based on ANOVA and TUKEY comparisons (Table-1). From the results of the present study it can be inferred that the physico-chemical parameters such as a Colour, pH, Electrical Conductivity, TDS, Total Hardness, BOD, COD, Magnesium, Calcium, Chlorides, Sulphates, Nitrate and Chromium of untreated tannery effluent was found to be higher than CPCB(1995) permissible limits and Dissolved oxygen of untreated tannery effluent was found to be lower than CPCB(1995) permissible limit. The

results suggest that the untreated tannery effluents collected from four stations is highly poisonous and release of such effluents into the water course will cause water and soil pollution and affects aquatic organisms drastically, and therefore, the effluent should be treated properly before discharge in the environment.

CONCLUSION

From the current comparative study of the physico-chemical factors of the tannery effluent in four different stations, the Ambur station seemed to contain highly toxic effluent compared to the other stations. Excess outflow of the toxic effluent will make the water body unfit for plants and other living organisms.

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