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Physicochemical characteristics of textile effluent collected from Erode, Pallipalayam, and Bhavani polluted regions, Tamil Nadu, India

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ABSTRACT

The present study perceives that textile dye effluents of Erode, Pallipalayam, and Bhavani region have substantial volume of electrical conductivity, pH, total dissolved solids, chemical oxygen demand, biological oxygen demand, sodium chloride, calcium, magnesium, potassium, and heavy metals. The results point out that irrespective of the source, effluent properties exceeded permissible limits by the WHO/Food and Agriculture Organization/Federal Environmental Protection Agency for irrigation. The textile industry consumes a mixture of chemicals and huge amount of water during the production process. About 200 L of water are used to produce 1 kg of textile. The textile effluent can cause several health infections such as hemorrhage, ulceration of skin, nausea, skin irritation, and dermatitis.

KEY WORDS: Heavy metals, physicochemical, Tamil Nadu, textile dye effluents

INTRODUCTION

Environmental pollution is one of the most important and vital nuisances of the modern world. Among them, industries are the utmost polluters of the native soil. Textile dyeing industry is one of the fast burgeoning production in India (80%), it consumes substantial volume of water and chemicals (Ahluwalia and Goyal 2007). It categorized by their high load of chemical oxygen demand (COD), biological oxygen demand (BOD), total suspended solids, total dissolved solids (TDS), extreme pH values, and color adding to their odor (Kabra *et al.*, 2013). However, their excess or insufficiency caused severe damage to the soil, ground water, and food chain production; which ultimately leads to be toxic to human health (Cheraghi *et al.*, 2011). In addition, cluster of dyeing factories do not have sufficient store for treating the effluents, and hence, it is release into the river without proper treatment thus making the river water unusable (Joo *et al.*, 2007). As far as western Tamil Nadu is troubled the rivers Amaravathy, Noyyal, Cauvery, and Bhavani are polluted by the discharge of effluent water from the nearby industries. Many industries, of late have installed reverse osmosis plants to neutralize and recycle the effluents. In addition, characterization of the effluent is important to resolve its reuse as a safe option due to its high water consumption. The present investigation was aimed to know the effect of dye industrial effluent on water quality of affected region.

MATERIALS AND METHODS

Experimental Site

The experimental site was located at Erode, Pallipalayam, and Bhavani of Tamil Nadu, India from June 2016 to December 2016. The experimental area received an average annual rainfall spread over the year.

Collection of the Textile Effluent

The effluent was collected from the textile industry situated at Erode, Pallipalayam, and Bhavani in clean plastic cans and stored at 4°C for physiochemical analysis. The raw effluent was directly collected from the outlet of the industry. The physicochemical personas of all the samples (textile effluent) were determined. These include the pH in H_2O using a glass electrode pH meter, electrical conductivity (EC), and TDS using the appropriate measuring devices. COD was determined using the titrimetric method, while dissolved oxygen (DO) was determined before and after an incubation period of 5 days in the dark at 20°C by the alkaline–azide modification of Winkler's method. The BOD was estimated from the amount of DO present in each sample before and after the incubation periods. For the determination of metallic elements, the dye effluent solutions were passed through 125 mm Whatman filter paper, and concentrations of Na, Cl, K, Ca, Mg, Cu, Cd, Pb, and Cr were read on atomic absorption spectrophotometer. All analytical methods followed procedures as described by APHA (2005).

RESULT AND DISCUSSION

To assess the changes in the quality of textile effluent of water samples was collected from selected town of Erode, Pallipalayam, and Bhavani taluks and analyzed to various physicochemical characteristics as per the methods prescribed in Table 1. The water samples collected from Erode, Pallipalayam, and Bhavani taluk showed not much variation in pH recording 8.75, 7.51 and 7.42, respectively, a small increase in pH above the critical limit of 6.5-8.5. The pH of the water sample indicates the neutral to alkaline nature which may be due to the pressure of bicarbonate which undergo hydrolysis in solution (Kulkarni and Pawar 2006). In general, the pH of water varies due to changes in temperature, biological activities, disposal of industrial wastes, and photosynthetic activities. In the present study, EC value is found to be higher 8330, 7610, and 7330 µmho/cm (Erode, Pallipalayam, and Bhavani) compared to unaffected regions, which is outranges within the maximum permissible limit of 2.25 ds/m for irrigation. EC is the capacity of a solution to conduct the electric current since most of the salts present in ionic forms, are therefore capable of concentration of salts because of discharge of industrial wastes of Erode, Pallipalayam, and Bhavani industrial area containing organic matter from the localized source to water bodies whereas the turbidity ranged from 89.6, 84.5 and 69.6 units nephelometric turbidity units (NTU). It refers to the amount of light that is scattered or absorbed by a fluid, it is measured in NTU based on the comparison of the scattering of light by a water sample with that of a standard suspension of formalin. Whereas, in the present investigation, the effluent released from trade was brown in color and had an offensive odor. The color of the effluent might be due to the presence of biodegradable and nonbiodegradable high-molecular weight organic compounds and high amount of chemicals used during the processing and the odor may be due to the processing of skin and hides by soaking and liming. The yellowish brown color might be hindering the penetration of sunlight causing depletion in the rate of oxidation process (Ravibabu *et al.*, 2007). In addition, levels of total

Table 1: Physicochemical characteristics of textile effluent collected from Erode, Pallipalayam and Bhavani polluted regions

Parameter	Erode	Pallipalayam	Bhavani
Appearance	Turbid	Turbid	Turbid
Color	Brown	Brown	Brown
Odor	Offensive smell	Offensive smell	Offensive smell
Turbidity-NTU	89.6	84.5	69.6
TDS (mg/L)	6040	5327	5131
EC (µmho/cm)	8330	7610	7330
pH	8.75	7.51	7.42
Calcium (mg/L)	134	120	104
Magnesium (mg/L)	19	17	16
Chloride (mg/L)	1485	1455	1385
Potassium (mg/L)	95	80	65
Sodium (mg/L)	2125	2050	1725
Sulfate (mg/L)	190	183	152
Phosphate (mg/L)	5.02	4.07	4.02
COD (mg/L)	859	802	609
BOD (mg/L)	450	340	260
Copper (mg/L)	13.21	12.34	10.40
Cadmium (mg/L)	12.61	11.49	10.87
Chromium (mg/L)	15.52	15.14	14.31
Lead (mg/L)	22.45	21.54	18.67

TDS: Total dissolved solids, COD: Chemical oxygen demand, NTU: Nephelometric turbidity units, EC: Electrical conductivity, BOD: Biological oxygen demend

suspended solids (TSS) found in the effluent (6040, 5327 and 5131 mg/L, respectively) were greater than that of the permissible limit (100 mg/L). The value was much greater than the tolerance limits (2100 mg/L) prescribed by Bureau of Indian Standards. However, BOD and COD of the water samples collected from Erode, Pallipalayam, and Bhavani regions ranged between 450, 340, and 260 mg/L, whereas the samples from unaffected regions recorded a BOD of 48-110 mg/L, and a COD of 859, 802, and 609 mg/L; it exceeded the critical limit of BOD for drinking water, 6 mg/L. The COD content of the samples also higher than the critical limit of 250 mg/L. The BOD is the amount of oxygen essential by bacteria while alleviate decomposable organic matter under aerobic conditions. The high value of COD indicates high potency of organic as well as inorganic pollution in the water (Dasgupta *et al.*, 2001). The sodium content accounted maximum of about 2125 mg/L in erode polluted regions, when compared to Pallipalayam 2050 mg/L and Bhavani 1725 mg/L polluted region. Most of the industrial wastes and domestic sewage are rich in sodium and increase its concentration in natural waters after disposal. High concentration of sodium in irrigation water affects soil permeability of textile and leads to pudding and reduced rate of water intake. In addition to sodium, the chloride content accounted maximum of about 1455 mg/L in erode polluted regions, when compared to Pallipalayam 1485 mg/L and Bhavani 1385 mg/L polluted region. Chloride is a major anion in waste water. Chloride concentrations increases due to increase in mineral content and produces salty taste in water as low as 100 mg/L concentration. Whereas, the sulfate content of the water samples were 190 mg/L (Erode), 187 mg/L (Pallipalayam), and 152 mg/L (Bhavani). The calcium content of water sample ranged from 134, 120, and 104 mg/L (Erode, Pallipalayam and, Bhavani, respectively) which exceeded the critical limit of 100 mg/L. The magnesium content was found to be 20, 17, and 16 mg/L in above-mentioned regions when compared to the unaffected regions which ranged between 12 and 48 mg/L. The potassium content was found to be 95, 80, and 65 mg/L in above point out regions when compared to the unaffected regions. Potassium is not insecure in water, but high concentration cause nerve and digestive disorder (Kulkarni and Pawar 2006). Sulfate is found in substantial quantity in all natural waters, particularly in arid and semiarid regions where natural water in general have high salt content. Further, the results on heavy metal analysis of water samples also showed the presence of heavy metals such as chromium, copper, cadmium, and lead. Water samples of affected regions Erode, Pallipalayam, and Bhavani recorded (15.52, 15.14, and 14.31 mg/L) chromium; (22.45, 21.54, and 18.67 mg/L) of lead; (13.21, 12.34, and 10.40 mg/L) of copper, and (12.61, 11.49, and 10.87 mg/L) of cadmium. Chromium, copper, cadmium, and lead contents of the samples lies within the maximum permissible limits of 0.05, 0.10, and 0.05 mg/L, respectively whereas, the lead content of the samples exceeded the prescribed limit 0.01 mg l-1 for drinking water. In similar to our results, Rajeswari *et al.* (2013) studied the various physicochemical parameters of textile effluents collected from Tirupur textile dyeing and common effluent treatment plants (CETP) units. Their results revealed that the most of the parameters were not within the permissible limit of polychlorinated biphenyl (PCB) standard. The effluent samples were differentially colored, with pungent smell, and pH of the dyeing unit had slightly above the neutral level and were within the permissible limit where as in the case of CETPs were not in the permissible limit. TSS in the dyeing as well as CETP effluent was high in the range of 222-896 mg/L. TDS in the textile dyeing effluent CETPs were very high in the range of 2459-3894 and 6801-9870 mg/L, respectively, also were not within the permissible limit of PCB standard. The COD was in the range of 997-1124 and 1987-2865 mg/L in dyeing and CETP effluent, respectively. The values were very much higher than maximum permissible limit of 120-400 mg/L according to PCB standard. The chlorides and sulfates were in the range of 1134-2865 and 786-2675 mg/L, respectively. Chloride occurs in all natural waters in widely changing concentrations. Excessive chloride in potable water is not particularly harmful and the criteria set for this anion are based primarily on palatability and its potentially high corrosiveness (Bhujangaiah and Nayak, 2005). Paul *et al.* (2012) reported very high concentration of sulfide in the ranges from 22 to 79 mg/L and average value is found to be 49 mg/L, which is about 25 times higher than Central Pollution Control Board standards. The degradation of water quality cascades several other direct and indirect implications such as change in cropping pattern, decrease in agricultural productivity, soil salinity, and change in biology of river, and depleting water table around Tirupur area. Eswaramoorthi *et al.* (2008) reported that textile effluents contain trace metals which are capable of harming the environment. Dyes in water provide a bad color and can cause diseases such as hemorrhage, ulceration of skin, nausea, severe irritation of skin, and dermatitis (Nese *et al.*, 2007). Ayas *et al.* (2007) were reported that heavy metal accumulation continuously disturbed the natural environment, particularly aquatic eco system. Prabha *et al.* (2013) reported that the presence of high Pb and Cd in the groundwater samples of Kasipalayam and Anaipalayam do not show any impact on the groundwater quality of the region. The untreated textile effluents released from the industries onto the open land seeps into the aquifer and increase the concentration. EC, TDS, Na, and Cl contamination of groundwater in Tirupur has been reported in various places because of large number of dyeing and printing units within the study area. The water used in the process is almost entirely discharged as waste, the average being 150-175 L of waste water for every kilogram of fabric processed. This poses a great demand for groundwater. Untreated effluents contain substances that could endanger the aquatic life.

CONCLUSION

From the result of physicochemical analysis of textile effluents has been concluded that pH, EC, TDS, BOD, COD, sodium, chlorides, potassium, calcium, magnesium, sulfates, and trace metals are very high in concentration compared to the standards prescribed by the WHO. The results of the study showed that due to unsafe disposal of textile waste water on the bare land, the organic, and inorganic chemical compounds present in the effluent have leached and found their way into the ground water. Hence, the potable water in the industrial area was significantly contaminated with cadmium, chromium, lead, and copper which were used in the wet finishing process of textile process and released along with the effluent. In the past, several physical and chemical methods have been recommended for the treatment of wastewater but are not widely used because of the high cost and secondary pollution that can be generated by excessive use of chemicals. In further, phytoremediation is novel technology that uses green plants for cleaning up of contaminated sites, as it seems to be a cost-effective, esthetically pleasant and may contribute to restore soil structure.

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