

Characterization of Physicochemical Parameters of Textile Effluents and Its Impacts on Environment

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ABSTRACT

Globally, textile industries play an important role in the economy of many countries. A huge volume of water is consumed in the various processes of dyeing fabrics and the majority of this is discharged with heavy loads of pollutants into the environment. The present study assessed the physicochemical characteristics of textile effluents from different areas of Salem, Tamil Nadu, India, where the city groundwater quality has decreased with increasing industrialization. The parameters of colour, pH and total hardness, biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), total suspended solids (TSS), chlorides, oil and grease were analyzed. Almost all the parameters were above the permissible limits set by the Bureau of Indian Standards (BIS). The high value of the pollutants shows that the effluents are discarded without proper treatment which may provoke hazardous effects on terrestrial and aquatic ecology and poses potential threats to the local environment. Although many conventional effluent treatment methods are implemented in many places, additional technologies still need to be developed for the complete removal of the pollution load.

1. INTRODUCTION

Environmental pollution through textile industry has become a major concern in the modern world. According to the Environmental Information System (2011) nearly 50% of the total industrial sewages generated in India is from the five major states of Tamilnadu, Uttar Pradesh, Maharashtra, Gujarat and Delhi. With 4% of the water resources, India accommodates 16% (approximately) of the world's population. Out of the available water resources, only 10% are safe enough to consume and the remaining regions are polluted with high concentrations of chlorine, fluoride, iron, arsenic and nitrate that exceed national safety limits. Furthermore, the increasing industrialization and urbanization has led to water stress among 54% of the people of India (Dutta, 2015). The increase in demand for textile products automatically led to the improvement of textile industries, the generation of increased wastewater, and severe pollution problems worldwide. Based on the raw materials used such as jute, cotton, silk, wool, and synthetic goods, the textile industries are distinguished and the volume of the water required for the process and wastewater

generated is determined. The textile processing includes various operations such as spinning, weaving, resizing, scouring, bleaching, dyeing, printing, finishing and clothing where water plays a crucial role.

Globally, more than 100,000 dyes are commercially available, out of which 70% are azo dyes, that are resistant to chemical and microbial attacks and remains stable in light and during washing (Zollinger, 1987). Of the 1 million tons of dyes produced per year, 50% is used as textile dyes (Boyter, 2007). Around 60,000 metric tons of dyes are produced in India for the dye industry, that approximates 6.6% of total colorants used worldwide (Teli, 2008). The dyeing process in textile industries involves more than 8,000 chemical products that include sulfides, salts, formaldehydes, metals and surfactants (Bhatia et al., 2017). During this process, approximately 10-25% of dyes used have been lost and about 2-20% of it is discharged with effluents in different environmental components (Ahmed et al., 2012). Apart from dyes, additives such as solvents, whitening agents, antifoaming chemicals, pH conditioners and finishing agents are used in the

different operations as substrates or as aqueous systems with bulk volumes of water and about the same level are discarded in the environment with variable characteristics and complex nature (Spagni et al., 2012). The other major pollutants in textile wastewaters include dissolved solids, suspended solids, biological oxygen demand, chemical oxygen demand, heat, colour, acidity, chloride, sulphur, metal ions and many other soluble substances (Mondal and Guha, 2011). Hence, it is unfeasible to illustrate a “typical” textile effluent because of its diversity in the process and the constituents used.

The Salem district of Tamilnadu, India, also known as steel city, is the major producer of magnetite, bauxite and many minerals. It is one of the main textile processing hubs of Tamilnadu and the largest regional market for agro products. A large number of Handloom societies and dye houses were established in these regions. It has more than 125 spinning mills with modern weaving and garment units. Cotton textiles category is the maximum units found in the Salem district and the main products from these regions are dhotis, silk sarees, cotton sarees, towels and bed sheets. The fabrics produced in Salem are exported throughout the world. A large number of powerlooms and autolooms are functioning in Salem, Idapady and Mettur Taluks (MSME, 2016). Handloom industries are most famous and a significant industry functioning at Ammapet, Kondalampatti, Elampillai and other Salem Taluks with an annual income of Rs. 5,000 crores.

The increase in industrialization and urbanization in the Salem district greatly exploited the forest and water resources. The effluent from the textile and dyeing industries in the city have affected agricultural lands, surface water and groundwater, in particular, the river Cauvery is polluted. The groundwater quality analysis of the Salem District showed that the water has to be purified for drinking purpose mainly from in areas like Hasthampatti, Kondalampatti and Chinnaseeragapadi in Salem, Tamilnadu, India (Krishnaraj et al., 2015). The water is also polluted due to weathering and ion exchange process, agricultural activities and anthropogenic activities (Arulbalaji and Gurugnanam, 2017). Surface water quality is very poor and chlorides, sulfate, dissolved solids, oil and grease in Tirupur, Tamilnadu are higher than the permissible limit (Jayanth et al., 2011). Underground water quality in and around Tirupur also showed higher deviations in

total alkalinity, total hardness, calcium, magnesium and chloride concentrations (Geetha et al., 2008) and increased salinity was reported in Singanallur, Coimbatore due to urbanization (Selvakumar et al., 2017).

Though various physical, chemical and biological treatment methods, such as neutralization, sedimentation, coagulation, flocculation, filtration, oxidation, adsorption, reverse osmosis, biological decolonization, ion exchange, phytoremediation (Anjaneyulu et al., 2005; Bansal and Goyal, 2005; Wu et al., 2008; Kaushik and Malik, 2009; Roy et al., 2010) etc., are adopted to reduce the pollutant levels from textile effluent, they are highly resistant to conventional treatment technology and have great impact on the environment. They act as teratogenic, carcinogenic and allergic agents in human beings besides showing growth inhibitions on different microbes, plants and animals (Suzuki et al., 2001; Sponza 2002; Joshi and Santani, 2012; Khan and Malik, 2014; Akarslan and Demiralay, 2015).

Many of the earlier works in different regions of Salem district provide a preliminary and superficial assessment of groundwater quality only. There is no significant scientific report on the investigation of textile effluents from these areas. Hence, the present study was designed to evaluate the pollution load by determining the physicochemical parameters of the textile industry effluents from different areas of Salem city. This study helps in finding the impact of the textile effluents on the physical and biological environment of Salem, Tamilnadu.

2. METHODOLOGY

2.1 Study area

Salem, the fifth largest city in Tamilnadu, India, covers an area of 91.34 km² (35.27 m²) shown in Figure 1. Geographically, it is located at the northern latitudes of 11° 14' and 2° 53' and eastern longitudes of 77° 44' and 78° 50' at an average elevation of 278 m (912 ft). The city is surrounded by hills such as Jarugumalai, Nagaramalai, Kanjamalai, Kariyaperumal, Shervaroy and Godumalai. It is bounded on the south by Namakkal district, north by Dharmapuri district, east by Villupuram district and west by Erode district. The major river systems in this district include a perennial river Cauvery and Vellar river. The major tributaries of Cauvery that flows in the western and

southern boundaries of the Salem district are Sarabanga and Tirumanimuttar that originate in the Shevroy hills. The other watersheds are river Swetha and river Vasishta that originate in Kollimalai and Chitteri hills, flow eastwards and southwards respectively to join Vellar river. Ammapet zone is a residential and industrial region located in the eastern part of Salem city with 784.59 km². Weaving is one of the important processes that function under

a weaver's co-operative society (MSME, 2016). Kondalampatti zone is a small neighborhood located to the south west of Salem city. It is famous for silk weaving and silk yarn trading (Jagadeesan, 2014). Figure 2 shows the mixing of textile effluents from small scale industries and domestic sewage with local water bodies in the study areas that leads to pollution.

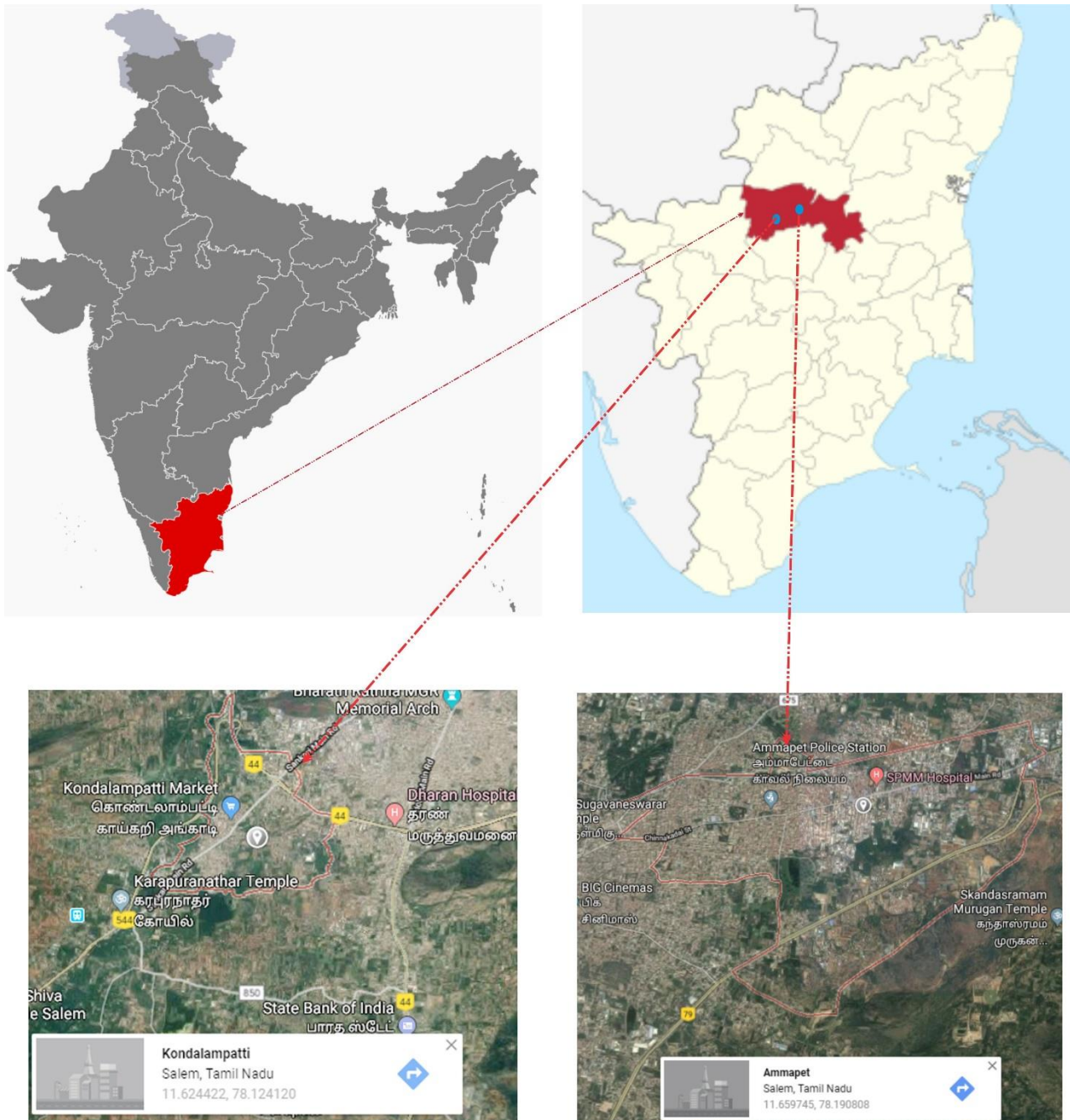


Figure 1. Location map of study area (Ammapet zone and Kondalampatti zone of Salem district, Tamilnadu, India)



Figure 2. Regions of effluents and sewage mixing with local water bodies in the study area.

2.2 Sample collection

A total of eight effluent samples were collected from the outlet of small scale textile processing and dyeing units located along the residential zone of Salem city, Tamilnadu, India for the study purpose. Four sample points (S1, S2, S3

and S4) covered Ammapet region and four samples (S5, S6, S7 and S8) were from Kondalampatti area.

The samples are collected at different days according to the variation in dyes used in the textile process (Table 1). Most textile dyes used in the sampling areas were found to be acid dyes.

Table 1. Details of sample collection

S. No	Effluent samples	Sampling sites	Common name	C.I. generic name	Chemical formula
1	S1	Ammamet	Red dye	Solvent Red 43	$C_{20}H_8Br_4O_5$
2	S2	Ammamet	Blue dye	Basic Blue 11	$C_{29}H_{32}N_3.Cl$
3	S3	Ammamet	Greenish blue dye	Acid Green 25	$C_{28}H_{20}N_2Na_2O_8S_2$
4	S4	Ammamet	Brown dye	Acid Brown 14	$C_{26}H_{16}N_4Na_2O_8S_2$
5	S5	Kondalampatti	Black dye	Carbon Black	C
6	S6	Kondalampatti	Darkish green dye	Acid Green 50	$C_{27}H_{25}N_2NaO_7S_2$
7	S7	Kondalampatti	Green dye	Acid Green 25	$C_{28}H_{20}N_2Na_2O_8S_2$
8	S8	Kondalampatti	Purple dye	Acid blue 1	$C_{27}H_{31}N_2NaO_6S_2$

2.3 Sample analysis

The physicochemical parameters analyzed were colour, pH, total suspended solids (TSS), total dissolved solids (TDS), total hardness, biological oxygen demand (BOD), chemical oxygen demand (COD), chlorides, oil and grease. The parameters are determined using standard protocols (Indian Standard, 2006) in triplicate and the results are compared with the Bureau of Indian Standards (BIS, 2003) for textile effluent characteristics.

2.4 Data analysis

Using analysis of variance (ANOVA), a

statistical technique, the significant difference in concentrations of various parameters has been analyzed. Differences in concentration levels obtained for a given parameter in each sample are considered significant if the calculated p-value is <0.05 . The mean and standard deviation of the parameters determined from the effluent samples were calculated using MS Excel.

3. RESULTS AND DISCUSSION

The physicochemical characterization of the selected effluents within the Salem city was determined and compared with BIS limits in Table 2.

Table 2. Physicochemical parameters of different textile effluents

Effluent samples	Colour (Hazen)	pH	TDS (mg/L)	TSS (mg/L)	Total hardness as CaCO ₃ (mg/L)	Chloride as Cl ⁻ (mg/L)	COD (mg/L)	BOD (mg/L)	Oil and grease (mg/L)
S1	9.6±0.5	8.2±0.1	15,643±8	392.7±2.5	1308±2	2,604±3	3,921.7±1.3	1,140.3±1.3	322±2
S2	9.97±0.05	8.6±0.1	4,870±2	211±1	459±1	991±1	3,674.7±0.5	1,110±1	188±1
S3	9.7±0.5	8.1±0.1	17,739±1	334±1	1,419.7±0.5	4,780.3±1.3	4,630±1	1,500.3±1.3	467.7±0.5
S4	9.7±0.5	8.37±0.05	9,593±2	385±1	922.3±2.1	1,911.7±1.3	3,249.7±1.3	779±1	363±1
S5	9.3±0.5	8.3±0.1	3,270.7±1.3	322±2	649±1	871±2	1,269±1	889±1	190.3±1.3
S6	9.7±0.5	8.26±0.05	8,370±1	220.3±1.2	859±1	1,811±1	2,477.6±1.3	752±2	193±1
S7	9.7±0.5	8.1±0.1	3,375±1	56.66±1.23	439.3±0.5	976±1	551±2	111.7±1.7	37±1
S8	5.7±0.5	8.4±0.1	2,931±2	154±1	541±2	819.33±1.70	821.3±1.3	74.6±0.5	67±1
BIS limits	25	6.5-9	2,100	100	500	600	250	100	10

3.1 Colour

One of the major problems, or the primary pollutant in the effluent of the textile industry, is colour which is formed by dyeing of fabrics. It typically varies depending on the industrial processes and dye marks used. The colour of the effluents selected is easily visible as shown in Table 1 and the absorbance of the true colour is also measured by Platinum-Cobalt (Pt-Co) standards in the UV-Visible spectrometer at the wavelength of 410 nm. The lowest colour units were found in S8 (5.67±0.5 Hazen), the other samples fall in the range of 9.9±0.5 to 9.3±0.5 Hazen (BIS limit: unobjectionable/ agreeable due to aesthetic consideration) (Figure 3). The most challenging dyestuffs are the water-soluble, intensely coloured, acid and reactive dyes and most of the dyes in the sample collection point are acid azo dyes. Although the acid dyes and cationic mordant are removed at high removal rates, it is very difficult to remove them by conventional treatment methods (Anjaneyulu et al., 2005). However, combined methods of physical and/or chemical with biological treatment towards removal of the dye has attention received (Garg and Tripathi, 2017). The results from the study indicate that the effluents contain colour producing compounds and metals obtained during fabrics dyeing and bleaching that are highly toxic and makes the receiving water unfit for further use.

Elango et al. (2017) also specified that one of the major problems in textile effluents is colour produced due to the usage of different dyes in the textile fabrication process. It prevents photosynthesis by blocking the sunlight and reduces the reoxygenation process; hence hindering the growth of photoautotrophic organisms. It also affects other parameters such as dissolved oxygen and BOD. The pH of the effluent and temperature also influence the intensity of the colour by preventing the degradation of chromophores.

3.2 pH

pH is an important factor to be determined in the analysis of water quality, since it affects chemical reactions such as solubility and metal toxicity (Fakayode, 2005), and alters biological reaction rates, thus causing adverse effects on the survival of aquatic plants, animals and humans (Sankpal and Naikwade, 2012).

The pH of the collected samples is found to be lowest in S3 with 8.1 ± 0.1 and highest in S2 with 8.6 ± 0.1 (BIS limit: 6.5 to 9) which shows a slightly alkaline nature (Figure 4). The alkalinity may be due to the usage of different types of dyes in the process. Similarly, Vigneshpriya and Shanthi (2015) showed that the pH of an effluent sample collected from Karur, a textile city in Tamilnadu, was 9.5. Patel et al. (2015) found that the pH was between 4 and 13 in

the textile industry effluent collected from southern regions of Gujarat. The pH influences the plant growth, survival of aquatic animals as well as the activity of useful microorganisms and also controls chemical treatment processes. Soil permeability is also altered by pH strength which results in underground water contamination (Robinson et al., 2002).

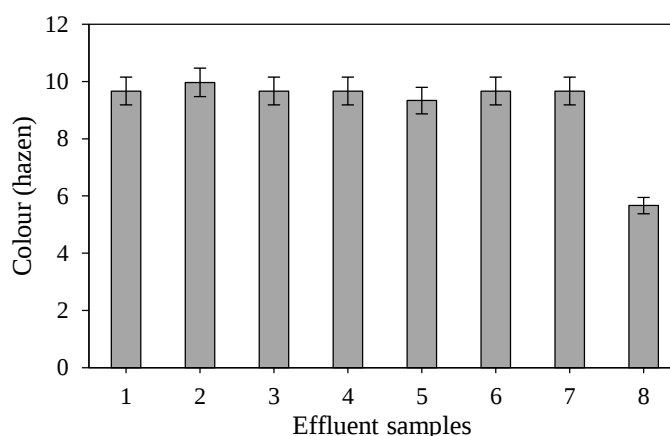


Figure 3. Analysis of colour of effluent samples

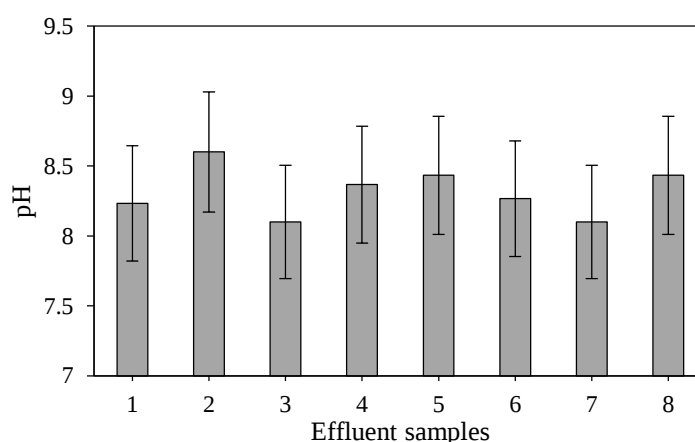


Figure 4. Analysis of pH of effluent samples

3.3 Total dissolved solids (TDS)

TDS is a measure of the total organic and inorganic substances contained in molecular, ionized or suspended form in water. It includes the presence of soluble salts like carbonate, bicarbonate, calcium, chloride, magnesium, nitrate, phosphate, sodium, and sulfate that yield ions. Dissolved salts in water cause skin dehydration in animals and give a laxative effect and unpleasant mineral taste to water. It increases the osmotic pressure of soil water that leads to increase in respiration rate thus declining the

growth and yield of most plants. At times it also increases the temperature (Leelavathi et al., 2016). The effluent showed a high level of TDS between the ranges $3,270.6 \pm 1.3$ mg/L in S5 to $17,739 \pm 1$ mg/L in S3. TDS values were found to be higher in Ammapet area (particularly S3 sample) when compared to Kondalampati samples. The values determined are much greater than the tolerance limits of 2,100 mg/L as prescribed by the Bureau of Indian Standards and shown in Figure 5. This higher level may be due to the discharge of chemical agents

used during various processes in the textile industries. As compared to the results obtained, Sathiyaraj et al. (2017) collected effluents from textile dyeing units of Erode, Pallipalayam, and Bhavani of Tamil Nadu and found that the TDS was in the range of 2,459-3,894 mg/L and 6,801-9,870 mg/L, respectively, that are above the permissible limit of pollution control board (PCB) standard. This high TDS value evokes salinity problem to the local environment (Kolhe and Pawar, 2011), and poses adverse impacts on aquatic life and agricultural perspectives (Roy et al., 2010; Kant, 2012).

3.4 Total suspended solids (TSS)

Total suspended solids represent the organic and mineral particles in effluents. It also includes carbonates, bicarbonates, chlorides, phosphates and nitrates of Ca, Mg, Na, K, organic matter, salt and

other particles. The TSS value of the effluents was between 56.6 ± 1.3 - 392.6 ± 2.5 mg/L and it was high in sample S1 of the Ammapet area. The result shows that sample 7 is under the Bureau of Indian Standards permissible level of 100 mg/L, while other samples are beyond the permissible limit (Figure 6). Sathiyaraj et al. (2017) also found the TSS value of effluents from textile dyeing units and common effluent treatment plants (CETPS) of Erode, Pallipalayam, and Bhavani of Tamil Nadu were high in the range of 222-896 mg/L. The high value of TSS increases sedimentation rates and turbidity level of water, thereby influencing the oxygen demand and reducing photosynthesis. It also increases the levels of pathogens and contaminants, thus distressing the food chain of aquatic biota (Giller et al., 1998). Hence, it has to be reduced before discarded into the effluents.

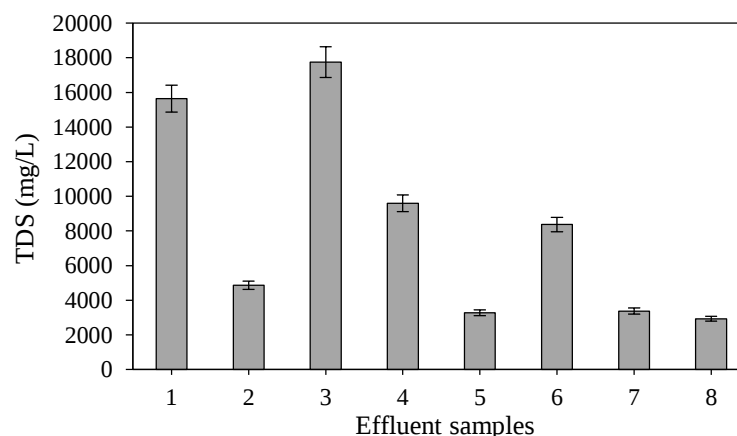


Figure 5. Analysis of TDS of effluent samples

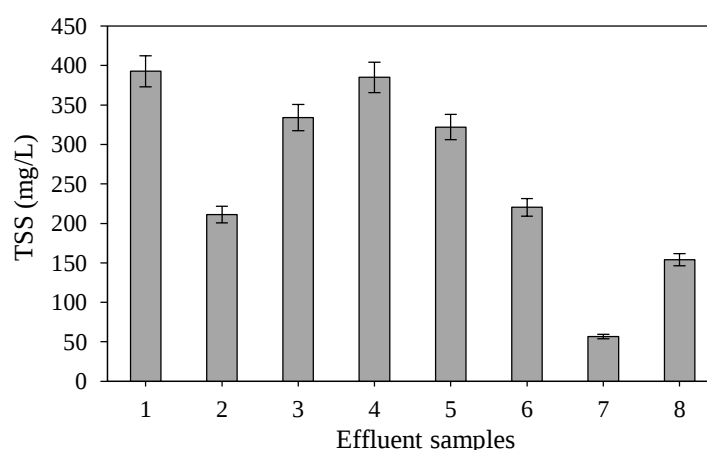


Figure 6. Analysis of TSS of effluent samples

3.5 Total hardness

The hardness of water represents the quality of water mainly in terms of Ca^{2+} and Mg^{2+} and

expressed as CaCO_3 . The hardness of the effluent samples was observed in the range of 439.3 ± 0.5 mg/L in S7 to $1,419.6 \pm 0.5$ mg/L in S3 as shown in

Figure 7. According to BIS, the maximum acceptable limit of hardness is 500 mg/L and it was found to be higher in the Ammapet area (particularly S1 and S3 sample). Sample 7 is within the permissible limit, the other samples are above the permissible limit which indicates that the water is hard. Consequently, the effluents should be softened before they are discharged into the receiving bodies.

Manikandan et al. (2015) observed high levels of hardness in the effluents collected from the textile industries of Tirupur. The rise in the level of total hardness may be due to the presence of carbonate and non-carbonate compounds (Ramesh et al., 2012). It results in increased alkalinity and pH in the nearby environments.

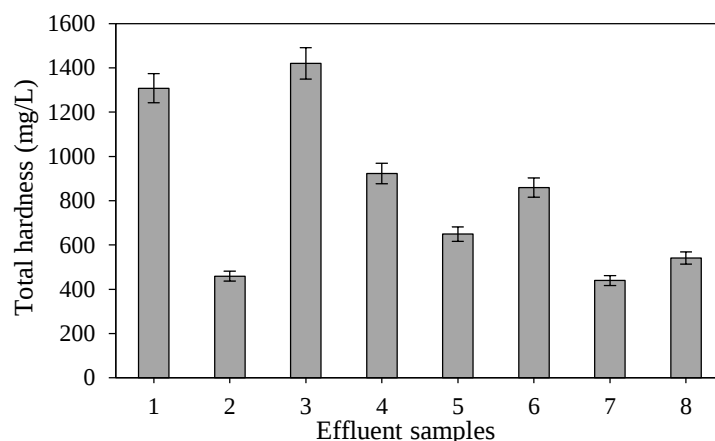


Figure 7. Analysis of total hardness of effluent samples

3.6 Chloride

In the present study, the amount of chloride was analyzed and recorded from 819.3±1.7 mg/L in S8 to 4,780.3±1.3 mg/L in S3, which exceeds the BIS tolerance limit of 600 mg/L, and their comparison is shown in figure 8. It was found to be higher in the Ammapet area (particularly S3 and S1 sample). Chloride is a pollutant only at higher concentration levels which is discharged in effluents due to the use of compounds like hypochloric acid, hydrochloric acid and chlorine gas during bleaching, washing and disinfection processes. It is the crucial

anion in industrial effluents that affect agricultural crops (Varma and Sharma, 2011). It kills the microorganisms in water and disturbs the aquatic food chain, increases corrosiveness and may cause adverse health effects to humans. It also influences electrical conductivity, alkalinity, TSS, TDS and sulfate levels. The concentration of chloride above 250 mg/L gives a salty taste to water due to the increase in mineral content. Manikandan et al. (2015) observed the concentration of chloride in the effluents collected from textile industries of Tirupur varied from 145 to 1,668 mg/L.

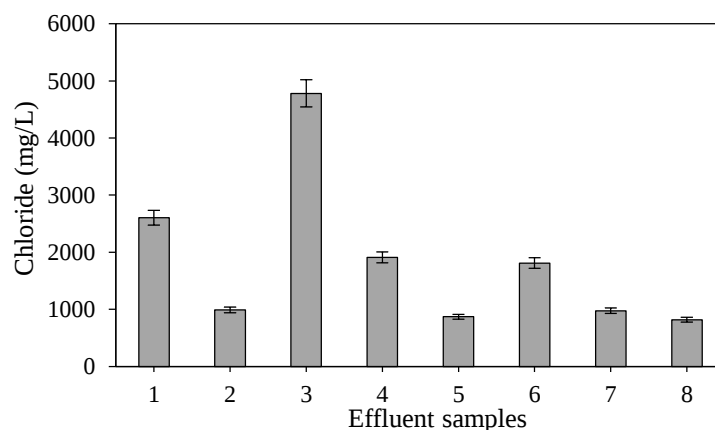


Figure 8. Analysis of chloride of effluent samples

3.7 Chemical oxygen demand (COD)

The measure of the demand for oxygen of oxidizable pollutants in effluents is represented as COD. It indicates the level of toxicity and the presence of biological resistant substances in water (Chaurasia and Tiwari, 2011). The COD of the selected samples are in the ranges from 551 ± 2 – $3,921.6 \pm 1.3$ mg/L (standard BIS limit of COD is 250 mg/L) represented in Figure 9. The COD value found to be higher in the Ammapet area (particularly

S3 sample). Roy et al. (2010) found that the COD levels were very high in the range of 800–2,304 mg/L, beyond the permissible limit to be mixed in the inland water surfaces. The high value of COD indicates the toxicity of the effluents and it may be due to the presence of non-biodegradable dyeing chemicals, softeners and detergents discarded during the process (Yusuff and Sonibare, 2004). Hence, the effluent has to be treated to support the survival of water living organisms.

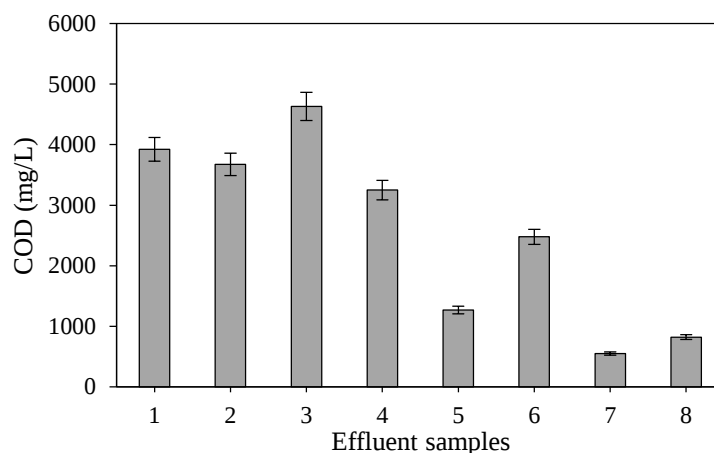


Figure 9. Analysis of COD of effluent samples

3.8 Biological oxygen demand (BOD)

The BOD is the measure of the amount of oxygen required by bacteria in the water to break the decomposable organic matter into simpler substances. The high values of BOD are indicators of the pollution strength of the water and specify that less oxygen is available for the living organisms in the wastewater. The standard BIS limit of BOD is 100 mg/L, but the samples collected showed BOD in the range from 74.66 ± 0.5 mg/L in S8 to $1,500.33 \pm 1.3$ mg/L in S3 that shows the water is

highly contaminated (Figure 10). BOD value found to be higher in Ammapet area (particularly S3 sample). Thangaraj et al. (2017) reported high levels of BOD from the effluents of the textile dyeing units in Pallipalayam area of Namakkal District. The increased BOD level causes the reduction of dissolved oxygen that may deplete the aquatic biota by inducing hypoxia conditions and other adverse effects, thereby increasing the anaerobic properties of water (Tishmack and Jones, 2003).

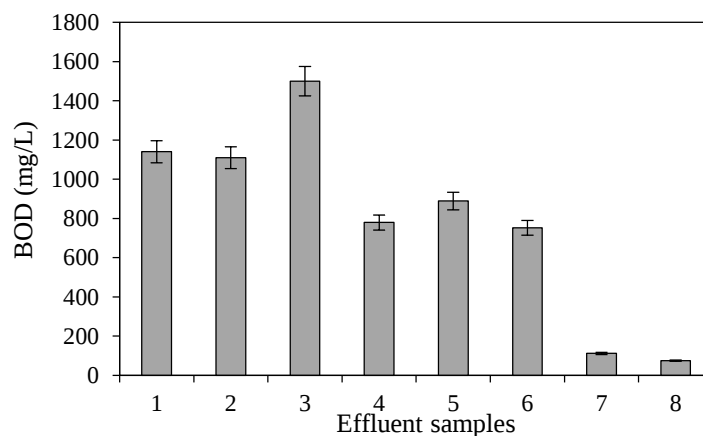


Figure 10. Analysis of BOD of effluent samples

3.9 Oil and grease

Oil and grease are Organic toxic waste discarded in the effluents and form a film layer on the water surface. It reduces the dissolved oxygen, thereby reducing the biological activity and damaging the aquatic ecology. The concentration of oil and grease in the selected effluents is determined to be in the range of 37 ± 1 - 467.7 ± 0.5 mg/L that is much higher than the BIS limit of 10 mg/L, charted in Figure 11. The value was found to be higher in the Ammapet area (in S3 sample) when compared to other samples. Elango et al. (2017) also recorded the

concentration of oil and grease as 18 mg/L from the textile dyeing effluent collected in the Tirupur regions of Tamilnadu. The suspended solid in the effluents combine with oil and grease in water bodies and obstruct the photosynthesis process, reducing the amount of dissolved oxygen (DO) and hence disturbing the growth of aquatic plants and the aquatic food chain. Hence, oil and grease concentration have to be reduced by proper treatment to prevent their accumulation in the water bodies.

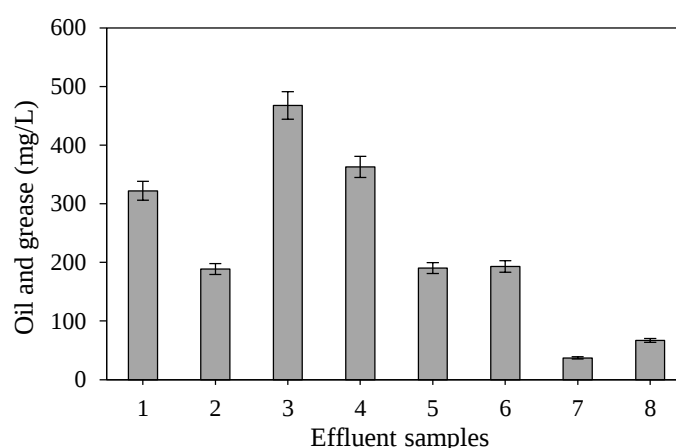


Figure 11. Analysis of oil and grease of effluent samples

The ANOVA for the test parameters colour, pH, total suspended solids (TSS), total dissolved solids (TDS), total hardness, biological oxygen demand (BOD), chemical oxygen demand (COD), chlorides, oil and grease of the effluent samples monitored are shown in Table 3. This statistical analysis of variance is performed to check whether

concentration levels of the test parameters are statistically significant or not. The calculated f-stat value is lower than that of the table value and the p-value is higher than that of the level of significance (calculated at 0.05). Thus there is not a significant difference among the effluent samples across Salem.

Table 3. ANOVA for the textile effluents

Source	ANOVA				
	Degrees of freedom (DF)	Sum of squares (SS)	Mean square (MS)	f-stat	p-value
Between test parameters	7	6.82×10^7	9.74×10^6	0.9774	0.455
Within test parameters	64	6.37×10^8	9.96×10^6		
Total	71	7.06×10^8			

The physicochemical analysis (Table 2) shows that the sample S3 from Ammapet has high TDS, total hardness, chlorides, COD, BOD, and oil and grease values. Sample S2 has high colour and pH and sample S1 has high TSS values. The discharge of colour in the effluents attributes to high TDS and

TSS values, and increases in BOD, COD and variation of the pH (Amin et al., 2008). COD values of the effluents were three to ten times higher than their respective BOD values and suggests a significant amount of dissolved oxygen is required for improved intrinsic remediation. The high value

of the parameters from all the samples studied shows that the effluents are discarded with high pollution load in Salem City. These effluents from the textile, dyeing and chemical industries pollute local surface and groundwater as well as the Cauvery river basins. The results obtained are in concurrence with the physiochemical analysis of various industrial effluents (Kaur et al., 2010; Srivastava, 1988; Baruah et al., 1993).

These effluents mixed with groundwater, increased the concentration of contaminants and make it unsuitable for drinking. The groundwater analysis in Salem district showed higher turbidity, TDS and Chloride in Kondalampatti than Ammapet regions pH, total hardness, Sulphate and Iron are higher in Ammapet regions. All the physicochemical parameters exceed the permissible limits and the water has to be treated before consumption (Dinesh and Geetha Selvarani, 2016). The salinity and alkalinity of the soil was also found to be increased and forcing soil problems due to the discharge of untreated industrial effluents. High BOD and COD levels lead to clogging of soil pores in the fields that result in loss of soil productivity (Kant, 2012). Certain heavy metals found in the discharge effluents get accumulated in the biological sources and finally leads to severe health problems like skin ulcer, haemorrhage, nausea, irritation of skin and dermatitis to humans (Tufekci et al., 2007; Sathya and Ravichandran, 2007).

Various wastewater treatment processes have been used to treat these effluents. However, the treatments are not found effective against the removal of all dyes, chemicals, heavy metals and other inorganic pollutants used in the industry and also they are expensive and require complex operations and maintenance (Rajasulochana and Preethy, 2016). Hence, suitable novel techniques with a low economical range have to be developed to remove all of these impurities and maintain the resources. A prototype model of effluent treatment plant with low-cost materials to remove the pollutant loads focused specifically for micro industries is under development.

4. CONCLUSIONS

The physicochemical characteristics of colour, pH, total hardness, BOD, COD, TDS, TSS, total chlorides, oil and grease of the textile effluents from different places of Salem were determined according

to the Indian Standard methods of water sampling and test and compared with standards of wastewater generation as defined by the Bureau of Indian Standards. The analysis shows that the parameters are beyond the set limit to be discarded in the environment. In particular, sample S3 from Ammapet region showed high pollution levels and other samples were significantly higher. These effluents are discarded without proper treatment and lead to pollution of surface water and groundwater making it unsuitable for drinking and irrigation purposes. It also affects the terrestrial as well as the aquatic ecosystem. Although technologies for cleaner production and initiatives for waste minimization are encouraged in many industries and common effluent plants are set in many textile industry areas, small-scale industries are unable to afford the process economically, since the conventional treatment methods are expensive. Development of economical, sophisticated, user-friendly methods for wastewater treatment from medium and small-scale industries is under process that avoids threatening of significant wastewater dependent livelihoods on one end and protects deprivation of valuable natural resources on the other end.

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