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Textile Dyeing Effluents and Environment Concerns - A Review

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Abstract

Textile dyeing effluent is considered as one of the most environmentally unfriendly industrial processes. The study aimed to review the different types of textile dyes use in the industrial processes and their contribution to environmental pollution in South Asian countries. The article was prepared to compile all present data from different journals and website on textile dyeing effluents characterization in South Asia. A wide variety of synthetic dyes like azo dye, vat, reactive dye, disperse dye, etc. widely used in the textile sector. The result showed that some physicochemical parameters of the dyeing effluents (COD, TDS and BOD) exceeded their standard limits. The industrial effluents are affecting the main devastation to the aquaculture, agriculture, ecology, environment, and public health since the development of textile dyeing industries in these countries. Now a day, its proper supervision and curative measures like removal system have become the furthermost thoughtful tasks all over the world and the developing and transition economies countries in particular. It is imperative to take immediate steps to reduce the environmental pollution due to discharge the untreated textile dye effluents.

Key words: BOD_5, COD, Industry, Pollution, TDS

Introduction

The textile industry is one of the largest industries in the world. The textile industry provides jobs without superior skills, which in turn plays a key role in providing employment in poor countries like India, Bangladesh, Pakistan, Sri Lanka, and Vietnam and therefore, plays a dynamic role in the growth of Gross Domestic Product (GDP) value of these countries (Keane and Velde, 2008). The textile dyeing industries have the great potentiality to caused water bodies pollution and the entire environment as well. It is estimated that over 10,000 various dyes and pigments are used industrially and over $7X10^5$ tons of synthetic dyes are yearly produced globally (Zollinger, 1987; Robinson *et al*., 2001; Ogugbue and Sawidis, 2013). With respect to the number and production volumes, azo dyes are the largest group of dyes, constituting 60-70% of all organic dyes produced globally (Bafana *et al*., 2011; Carliel, 1998). Textile materials can be dyed using batch, continuous or semi-continuous processes. The kind of process used depends on many characteristics including type of materials such as yarn, fabric, fiber, garment and fabric construction, as also the generic type of fiber, size of dye lots and quality requirements in the dyed fabric. The batch process is the most communal method used to dye textile materials among these processes (Perkins, 1991). The industry ingests an extensive amount of water in its industrial processes used generally in the dyeing and finishing operations of the plants. The effluents from textile plants are categorized as the most adulterating of all the industrial sectors, considering the volume produced as well as the effluent composition (Sen and Demirer 2003; Dos Santos 2007; Ben Mansour *et al*., 2012). The textile effluents contain organic and inorganic compounds (Elliott *et al*, 1954). During the dyeing processes, there is always a portion of applied dyes remains unfixed to the fabrics and is washed out. The unfixed dyes are found to be in high concentrations in textile effluents. In addition, the enlarged demand for textile yields and the comparative increase in their production and the use of synthetic dyes have contributed to dye wastewater becoming one of the significant sources of severe pollution problems recently (Dos Santos *et al.*, 2007; Ogugbue and Sawidis, 2011). The review article has been primed to gather the present status of textile dyeing effluent and its environmental concerns in South Asia and Bangladesh, in particular.

Status of textile industry in South Asia

The textile dyeing and washing industries play an important role in the economic growth of south Asia namely India, Bangladesh, Pakistan and Sri Lanka. In terms of its manufacture or production and employment, the textile industry is one of the biggest industries in the world. The textile industries of Bangladesh are an amalgamation of small and large-scale communal and private companies. The diligence is providing 45% of industrialized workers with employment. More than 4 million people of the countryǿs total population of which more are the women involved in these productions (Dey and Islam, 2015). The textile industry is the primogenital and largest industry of India. The industry generates about 14% of manufacturing production in the country and grosses 17% of its total exports. The textile industry of India delivers employment opening to 35 million people of the country (Tahir and Mughal, 2012). The role of the textile industry of Pakistan in the gross economic actions has been identical positive and unique. The textile sector enjoys a focal site in the exports of Pakistan. Pakistan is the eighth highest exporter of textile products in Asia. The involvement of this industry to the total GDP is 8.5%. It affords occupation to about 15 million people, 30% of the country workforce of about 49 million (Ahmed, 2008). Textile hubs in India are Tirupurand Coimbatore, Bangalore, Ahmedabad, Ludhiana, and Panipat. Tirupur is the largest textile hub in India. Faisalabad, Lahore, Karachi are the Textile Hubs in Pakistan and Faisalabad is the largest textile hub. Textile hubs in Bangladesh are Dinajpur, Gazipur, Dhaka, Chittagong, Narayanganj and Khulna. Dhaka is the largest textile hub in Bangladesh and Colombo is the largest textile hub in Sri Lanka. A figure has been made based on the leading textile exporting country, 2013 in South Asia according to the published report (Business Sweden, 2015) and is shown in Fig. 1.

Classification of dyes

Dye molecules consist of two main components namely the chromophores, liable for generating the color and the auxochromes, which cannot only add the chromophore but also reduce the molecule soluble in water and add an improved affinity toward the fiber (Christie, 2001).Dyes may also be classified because of their solubility as soluble dyes, which include acid, mordant, metal complex, direct, basic, and reactive dyes; and insoluble dyes including azoic, sulfur, vat and disperse dyes (Dos Santos *et al*., 2007).

i. Azo dyes

Azo dyes are considered by the presence of one or more azo bonds (-N=N-), in association with one or more aromatic structures. They consider carrying high photolytic stability and resistance towards major oxidizing agents. They have an inclusive diversity of presentation in textile industries (Carliell, 1995; Chung and Stevens, 1993).

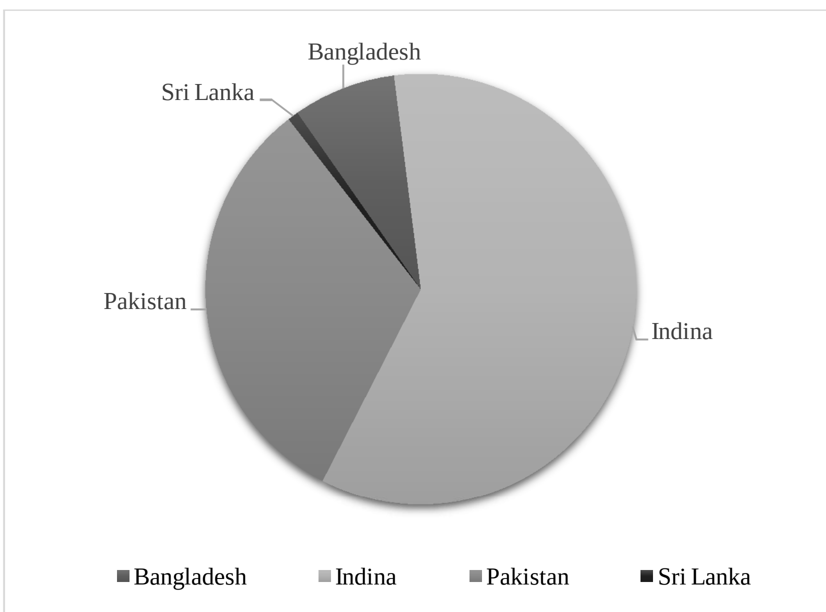


Fig. 1. The leading clothing exporting country in south Asia

ii. Anthraquinone dyes

Anthraquinone dyes found the second most plentiful class of textile dyes, after azo dyes (Baughman and Weber, 1994). These dyes have an extensive range of colors in almost the completely visible spectrum. Anthraquinone-based dyes are the most unaffected to degradation due to their glued aromatic structures, which persist colored for long periods of time (Fontenot *et al.,* 2003).

iii. Metal-complexes

Metal-complex dyes are amalgamations of a dyestuff and a metal (generally chrome). They were developed from the older mordant dyes and are very light-and wash-fast, metal-based complex dyes, such as chromium-based dyes, their use could lead to the discharge of chromium, which is carcinogenic in nature, into water supplies (Banat *et al.,*1996).

iv. Direct dyes

Direct dyes are used in the dyeing of cotton, rayon and nylon. They are anionic dyes; generally, the dyes in this class are poly azo compounds, along with some stilbenes, phthalocyanines, and oxazines (Hunger, 2003).

v. Basic dyes

Basic dyes are used for polyacrylonitrile, modified nylons, modified polyesters, cation dyeable, and polyethylene terephthalate. These dyes produce colored cations in solution and that is why they are called cationic dyes. The principal chemical classes are diazahemicyanine, triarylmethane, cyanine, hemicyanine, thiazine, oxazine and acridine (Hunger, 2003; Christie, 2007).

vi. Reactive dyes

Reactive dyes are soluble in water that need moderately simple dyeing methods; they are generally used for dyeing cellulosic fibers, such as cotton and rayon (Yang *et al*., 2005).

vii. Sulfur dyes

Sulfur dyes have transitional structures and though they form a moderately small group of dyes, the low charge and good wash fastness goods make this class important from a commercial point of view (Hunger, 2003).

viii. Vat dyes

Vat dyes are extremely fast dyes used for cotton mainly to dye cellulosic fibers as soluble salts and for rayon and wool too. These dyes are with a principal chemical class containing anthraquinone (including polycyclic quinones and indigoids) (Christie, 2007).

Application of dyes

Dyes are widely applied on paper, leather, fur, hair, drugs, cosmetics, waxes, greases, plastics and textile materials. Various types of dyes have widely used in the Textile sector. Most of the dyes are used in manufactured fiber (nylon), natural fiber (silk, wool), etc. (Sohel, 2012).The generally used dyes for artificial fibers are dispersed dyes. They are normally used in the Printing of polyesters, nylon, and acetates. Dispersed dyes are categorized into three types founded on their energy. These dyes are usually linked to benzene and naphthalene rings, but can also be involved in aromatic heterocycles or enolizable aliphatic groups. The side groups attached imparts the color to the dye (Ghaly *et al*., 2014). Tetrakisis used as a dye for synthetic fiber (Fig. 2). Some common dyes and their structures are shown in Table1.

Toxicity of textile dyeing effluents

The textile dyeing industries produce a huge amount of effluents, dirt slurry and solid waste ingredients every day. In textile dyeing effluents, heavy metals such as iron, lead, nickel, copper, zinc, and chromium are present in trace amounts. The synthetic azo dyes are carcinogenic and toxic posturing a severe health risk to human health. These dyeing effluents are being quitted into the adjacent waterway, farming fields, irrigation channels, exterior water and these lastly arrive into the water bodies like river, sea, etc. Textile and dye industrial effluents may cause variation of the physical, chemical, and biological nature of aquatic atmosphere by the nonstop alteration in turbidity, odor, noise, temperature, pH, etc. that is injurious to community health, livestock, wildlife, fish and biodiversity. The presence of dyes in surface and subsurface water is making them not only appealingly intolerable but also sources many water-borne diseases, viz. mucous membrane, dermatitis, perforation of the nasal septum and severe irritation of respiratory tract. Adulteration to this aquatic system carries severe hazard to the inclusive epidemic and socio-economic outline inside (Islam *et al*., 2011).

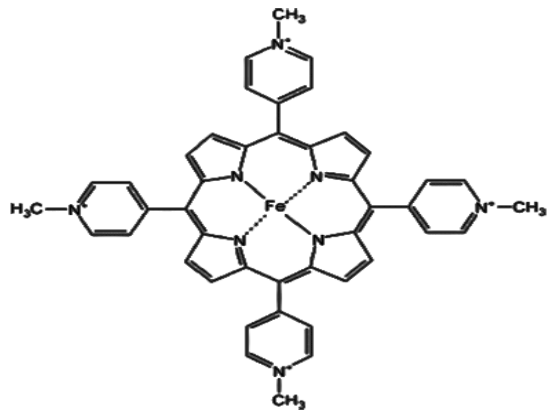


Fig. 2. Structure of Tetrakis

Characterization of textile dyeing effluents

Dyeing is the most complex of the wet processes, which includes hundreds of dyes and auxiliary chemicals such as fixing agents, acids, alkalis, etc. Mostly synthetic dyes are used for the dyeing process. About half of the total volume of wastewater is generated from the dyeing process only. Their dark color, high BOD5, COD, suspended solids and dissolved solids characterize generally dyeing effluent. Some of the main parameters of textile dyeing effluents are briefly discussed.

i. Color

Color is not included in the Environment Conservation Rules (1997) but it is a subject in textile dyeing effluents because unlike other pollutants it is so visible. The color of effluents is therefore important for the communal awareness of a factory.

ii. BOD_5 and COD

BOD_5 is a degree of the quantity of dissolved oxygen castoff by microorganisms in the biochemical oxidation of the organic matter in the wastewater overa5-day period at 20^oC. COD is a measure of the oxygen equivalent of the organic material chemically oxidized in the reaction and is determined by adding dichromate in an acid solution of the wastewater.

iii. DO

Dissolved oxygen measures the amount of gaseous oxygen (O_2) dissolved in an aqueous solution. Oxygen acquires into the water by circulation from the surrounding air, by aeration (rapid movement), and as a waste product of photosynthesis.

iv. TDS and TSS

Wastewater can be analyzed for total suspended solids (TSS) and total dissolved solids (TDS) after elimination of abrasive solids such as rags and grit. A sample of wastewater is filtered through a standard filter and the mass of the deposit is used to calculate TSS. Total solids (TS) are found by evaporating the water at a specified temperature.

v. EC

Electrical conductivity is generally used for demonstrating the total concentration of the ionized components in an aqueous environment. Since the electrical conductivity is a measure of the capability of water to conduct electrical current (Dey and Islam, 2015).

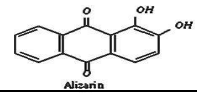
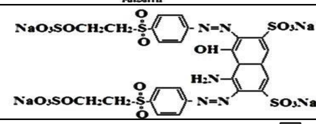
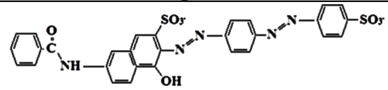
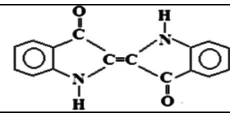
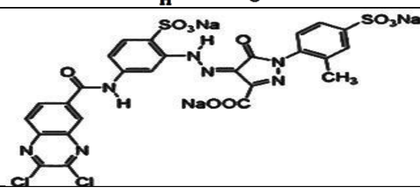
vi. pH

pH is a measure of the negative logarithm of hydrogen ion concentration in the effluent and gives an indication of acidity or alkalinity of the textile dyeing effluent. This factor is important because aquatic life such as most fish can only survive in a narrow pH range between roughly pH 6-9.

Pollutants of textile dyeing effluents

Textile printing and dyeing processes include pre-treatment, dyeing, printing and finishing. These processes produce huge amounts of effluents containing starch, waxes, Carboxyl Methyl Cellulose (CMC), polyvinyl alcohol, wetting agents, sodium hypochlorite, Cl_2, NaOH, H_2O_2, acids, surfactants, Na_2SiO_3, sodium phosphate and short cotton fiber. The potential specific pollutants come out from the textile printing and dyeing processes. The pollutants are dissolved solids (DS) of starch, strongly colored, high BOD_5, DS, low SS, heavy metals, oily and slightly alkaline (Ghaly *et al.*,2014).

Table 1. Some common structure of dyes

Dyes	Structure	Ref.
Anthraquinone Dyes		Wikipedia,2019
Remazol		Mukherjee , 2014
Direct Dyes (Direct red 81)		Ghaly *et al.,*2014
Indigo dyes (Dark blue)		Wikipedia, 2018
Drimarene K		Mukherjee, 2014

Some physicochemical parameters of textile dyeing effluents of different industrial locations in Bangladesh, India, and Pakistan are shown in Table 2, 3 and 4, respectively. The study depicted that the nature of the textile dyeing effluents is alkaline due to the excessive use of bleaching powder in the industries of Bangladesh (Table 2). The EC of the effluent was found in the range of 250-7950 εS/cm which is higher than the standard limit (1200 εS/cm) of DoE (2008). The higher EC indicates a large number of ionic substances in textile effluent Bangladesh (Table 2) (Roy *et al*., 2010). In most cases, BOD and COD values were higher than discharge standards. The higher levels of BOD are indications of the pollution strength of the effluents. The higher COD levels indicate the toxic situation and the existence of biologically resistant organic constituents (Sawyer and McCarty, 1978). The notable increase in COD levels compared with BOD also indicates that the significant levels of toxicants heavy metals may be possibly present in the effluents (Chavan, 2001). The value of TDS and TSS were higher (Table 2) and indicating a reflection of the oxygen amount required to produce both organic and inorganic solids present in the textile dyeing effluents (Uwidia and Ejeomo, 2013).

Table 2. Physicochemical parameters of textile dyeing effluents collected from different areas of Bangladesh

Area	Temp (^{o}c)	pH	TDS (mg/l)	COD (mg/l)	BOD_5 (mg/l)	EC (μs/cm)	Ref
Dhaka(DEPZ)	37-65	8.7-10	460-5981	508	90-460	250-7950	Kamal *et al.*,2016
Gazipur	34.7-48.8	8.9-10	531-1006	-	560-965	0.88-1701	Sultana*, et al.*, 2013; Hannan, *et al.,*2011
Narshindi	-	5-14	127-2676	-	-	-	Guha,2010
Narayanganj	50	6.8-11	152-1011	268-1275	60-450	592-1696	Sultana, *et al*., 2013
Chittagong	25-55	8.9-11	685-1338	487-1120	140-420	1108-1907	Sultana, *et al*.,2013
Pabna	-	6.8-11	152-1011	208-1275	60-450	592-1696	Sultana, *et l*.,2013
Standard(*DoE)	50	6.5-9	2100	200	50	1200	Ghaly *et al.,*2014

**DoE= Department of Environment*

Based on the literature reports on the effluent characterization, it could be said that the major four textile oriented industrial areas like Punjab, Tamil Nadu, Maharashtra and South Gujrat in India are polluted through discharged of untreated effluents from the textile dyeing industries. The textile dyeing effluents of two states in Pakistan exposed highly polluted to the environment. Reports showed that the major physicochemical parameters of textile dyeing effluents including pH, COD, BOD, TSS and TDS exceeded the BIS-standard permissible limits (Table 3) and the NEQS limit (Table 4). Therefore, the effluents of the industries of the states were unsuitable for the existence of biodiversity in the environment.

Table 3. Physicochemical parameters of textile dyeing effluents collected from four areas of India

Area	pH	COD (mg/l)	BOD_5 (mg/l)	TS/TSS (mg/l)	TDS (mg/l)	Ref
Punjab	4.30-11.90	120-3000	108-790	450-51450	430-49440	Kaur and Sharma, 2015
Kongu, Tamil Nadu	8.66	3080	970	7116	242220	Elango *et al*., 2016
Maharashtra	7.9-9.5	548-816	158-226	128-192		Amte and Mahaska, 2012
South Gujrat	4-13	32-58	72-93	40-160 (TS)	8-20	Patel *et al.,*2015
Standard (*BIS)	5.5-9	250	30	2100	150	Ghaly *et al.,*2014

*BIS= Board of Indian Standard

Table 4. Physicochemical parameters of textile dyeing effluents collected from two areas of Pakistan

Area	Temp. (°C)	pH	TDS (mg/L)	TSS (mg/L)	COD (mg/L)	BOD_5(mg/L)	Ref.
Faisalabad		8-14	2700-4200	66	590-880	211-487	Nosheen *et al.,*2000
Karachi	36-49.2	7.5-11.55	2469-7295	934-1875	115-705	85-653	Imtiazuddin *et al*., 2012
Standard (*NEQS)	Up to 40	6-9	3500	150	200	80	Imtiazuddin *et al*., 2012

**NEQS= National Environmental Quality Standard*

Impact of dyeing effluents on environment

Environmental difficulties related to the textile industry are classically those allied with water pollution caused by the discharge of untreated effluent. Some of the chemicals including dyes and pigments are noxious or can reduce the dissolved oxygen content of receiving waters, threaten aquatic life and ruin general water quality downstream. It has been observed that dyeing losses contribute to only 10- 30% of BOD_5 of the total, with respect to COD, the contribution of dyes themselves is around 2-5%, while that of dye bath chemicals is as high as 25- 35%. Acetic acid (used in disperse dyes on polyester, cationic dyes on acrylic fibers and acid dyes on wool, silk, and nylon) exerts a high BOD_5 and can account for 50- 90% of dye house BOD_5. Dyes can remain in the environment for an extended period because of high thermal and photo stability to resist biodegradation. The untreated textile dyeing effluents affect every component of the environment namely soil, water, air and human health of the environment (Shaikh, 2009) and are discussed below.

Impact on water

The textile dyeing effluent suits the source of pollution of the exterior water. Groundwater pollution deliberated to be the most significant source of drinking water. It is noted that groundwater is unpolluted still now (Sayed, 2015). Mills release a huge volume of textile dyeing effluent as unsafe toxic waste, full of color and organic chemicals from dyeing and finishing salts. Presence of sulfur, naphthol, vat dyes, heavy metals, and certain auxiliary chemicals all jointly make the effluent extremely toxic. Lutra (2017) illustrated the effluent generated in textile industries of different states in India in MLD and is shown in Fig. 3. The textile industries of Gujrat discharged the largest volume of textile dyeing effluents than other states in India.

Other unsafe chemicals present in the water may be formaldehyde-based dye fixing agents, hydrocarbon-based softeners and non-biodegradable dyeing chemicals. In the textile industry, up to 200000 tons of dyes are lost to effluents every year during dyeing and finishing operations due to the inefficiency of the dying process. Colloidal materials increase the turbidity and give the water a ruthless appearance and vulgar odor due to the presence of coloring and oily scums (Kant, 2012).

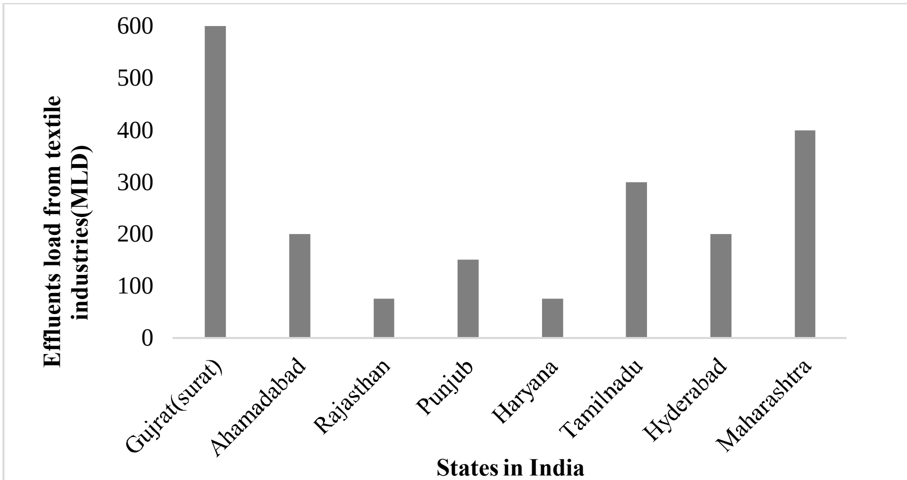


Fig. 3. Effluents generates from textile industries at different states in India

Water pollution in Pakistan has arisen from multiple pollution sources alongside old, rusted and ineffective distribution networks. Water pollution occurs during scouring, bleaching, and dyeing. Malir and Lyari are major rivers in the city receiving effluents from these industries and draining into the Arabian Sea. Both the rivers run across the entire city carrying pollutants and dumping into the sea (Nergis *et al.*, 2009).A Researcher stated that the water bases of Faisalabad in Pakistan are polluted due to the discharged of untreated effluents. A large volume of fresh water is utilized by dye houses in the estate and open drains have been used for effluent discharge. These discharging effluents enter and pollute the canal that flows into a much larger water body (River Chenab). The pH of effluents for discharges was slightly alkaline due to the extensive use of salts in dyeing (Ashfaq, 2015). 41 textiles industries are located in coastal areas of Sri Lanka. These industries discharge 7100 wastewater (m^3/day). BOD_5 (Kg/day) and COD (mg/L) of textile dyeing effluents are 4979 (Kg/day) and 11310 (mg/L) which are greater than discharge limits (Table 2). Textile wastewater load in coastal areas with great or average pollution (Azmy, 2013). The Kelani River is the most highly polluted river in Sri Lanka. There are several textiles factories discharging organic dye waste into the Kelani downstream of Hanewella and some of these dyes may increase poisons in river water. Water pollution due to the textile industry (percentage of total BOD_5 emissions) in Sri Lanka was reported at 43.56 % in 2006, according to the World Bank collection of development indicators, compiled from officially recognized sources. A study reported that the water of Kelani river are loaded by pollutants of the effluents including coliform 5000 (per 100), total N 7.0-8.0 (mg/L), total P 0.12-0.03 (mg/L), Zn 52.5 (ppb), Cd 2.7(ppb) and Pb 7.4 (ppb), respectively. This discharge of textile dyes to the Mahalaya at Thuihiriya is another example (Ileperuma, 2000).

Impact on soil

The soil is the natural body made of mineral and organic constituents. The soil is the basis for agriculture. Textile effluent pollutes the soil. When this effluent is permitted to run in the fields, it obstructs the pores of the soil causing in loss of soil yield. The consistency of soil is toughened and permeation of roots is prohibited. Now a dayθs effluent from textile dyeing industries is unsafe for soil. A researcher stated that the effluent of Modi Textile factory Ltd. Modinagar, Uttar Pradesh in India was alkaline and reddish brown in color , deficient in DO contained huge amount of solids (dissolves, suspended and volatile) and large values of BOD_5, COD besides these effluents contains NH_4-N (32 mg/L), P (17 mg/L), chloride (780mg/L), SO_4-2 (400 mg/L), Na (195.5 mg/L), Ca (280mg/L), Mg (140mg/L). Textile hand processing industries in Pali, Jodhpur and Barmer districts release huge amount of effluents in nearby continuing rivers viz Bandy, Jojri and Luni, respectively and causing serious geo environmental contamination and anthropogenic hazards. A study on the effect of textile dyeing effluents on soils collected from the agricultural fields adjoining to the textile dyeing effluents outlet in Jojripur river at Salava's showed higher accumulations of Na (295.54mg/100g) P (35.5 mg/Ha), high K (308.2mg/ha). Several Researcher has reported that the addition of textile effluents to soil even on short term basis result into decline in water-soluble salts organic matter Na, Ca, Mg, K, NH4-N and P content of the soil as compared to normal water irrigated soil (Chhokor *et al.*, 2000). Many researchers predicted that at high concentration of various effluents such as textile consequence in reduced germination (Nagada *et al.*, 2006; Raman *et al*., 2002). A researcher stated that kidney bean and ladyfinger had reduced germination percentage in the presence of manufacturing effluent. However, there was an unsafe outcome in the presence of treated textile dyeing effluent (Ajmal and Khan, 1985). Decreasing in germination and early progression of radish, turnip, and brassica occurred due to the solicitation of raw textile dyeing effluent, which was more noticeable in turnip while less declining was seen in turnip and brassica with much watery raw textile dyeing effluent (Rehman *et al.*, 2009). Other researchers studied that the result of textile dyeing effluent on germination and growth of black gram Vigna Mungo L. and showed that below lesser concentration of the effluents, the germination and sapling growth was higher than the control but there is generally decrease in upper concentration of the effluents (Wins and Murugan, 2010). The best germination and sapling growth was observed in 25% concentration. So they concluded that textile effluents could be safely used for irrigation after proper treatment and dilution at 25%. The presence of very dilute industrial waste (5%) the seed germination of Cicer arietinum is reduced harmfully (Dayama, 1987; Swaminathan and Vaidhecswarn, 1991).

Impact on human health

The application of dyestuffs and pigments in textile and dyeing industries may cause a number of antagonistic effects on health. Many different groups of chemical materials are used in the textiles sector, comprising optical brighteners dyes, heavy metals, crease-resistance agents, antimicrobic agents, solvents, pesticides and flame retardants (Mahmud *et al.*, 2011). About 40% of globally used colorants contain organically bound chlorine, a known carcinogen (Malik and Khan, 2013). The usual functioning of cells is disturbed and this, in turn, may cause an alteration in the physiology and biochemical mechanisms of animals are resulting in the injury of important function like respiration, osmoregulation, reproduction, and even mortality due to the toxic nature of the textile dyeing effluent. Textile materials can cause allergic reactions. It was found that workers acquired dermatitis, asthma, nasal problems and rhinitis after prolonged exposure to reactive dyes. The people in the Noyyal river basin at Tamil Nadu in India are very much upset due to huge ingesting of contaminated wastewater (Elango *et al.*, 2016).

Bangladesh perspective

The study has emphasized the effect of discharging untreated textile dyeing effluents in Bangladesh and is briefly discussed here. Most of these textile industries are situated along the bank of the rivers in Bangladesh. A complex mixture of dangerous chemicals both organic and inorganic discharges into the aquatic bodies from all these industries, generally without treatment or partial treatment. About 40,000 m^3/day textile effluents and 26,000 Pollution load (BOD_5 kg/day) are discharged by these industries. Factories and industries at Tongi close to Dhaka regularly tip effluents in the nearby river and polluting water. The water of the Turag is a dark color and has a strong smell. The researcher found that the concentrated values of pH, EC, TDS, DO and BOD_5 were 7.24-7.61, 425-2277 µS/cm, 239-1349 ppm, 1.22-3.66 ppm, and 2.44-0.86 ppm, respectively. Saver which is the foremost manufacturing belt near Dhaka in Bangladesh has more than 85 local and foreign manufacturing in the old and new EPZ zones where most of them are textile and dyeing industries. The industries of Saver produce a huge amount of effluent every day, which are being nonstop quitted into the neighboring land, farming fields, irrigation networks, and exterior water and lastly enter into the river. A researcher analyzed water samples of Saver for pH, temperatures, DO, BOD_5, COD, total EC, TDS and TSS and most of the parameters exceeded the discharge limit (Mia, 2001). The industrial effluents are regularly quitted into Dhalai Beel, which then entered into the Bansal River without any treatment. Therefore, the extremely concentrated heavy metals become unsafe to fish and microorganism of the Dhalai Beel (Sultana, 2003). There are industrial units at Fatulla, Panchabatee, Kachpur, Rupashi, Tarabo, Hotabo, Sonargaon, Araihazar, Rupganj and Gopaldee. Moreover, there are dyeing/printing factories, textile mills along the

Dhaka- Chittagong highway. Many of these industrial units discharge effluents directly into the river Shitalakkhya. The Bangladesh Center for Advanced Studies (BCAS) analyzed that EC of Shitalakkhya river snappy the boundary and it was 110 micro S/cm during 1980 but destructive industrial development and erroneous farming actions, it increases up to 1440 micro S/cm through 1998 and TDS increases 216 to 446 mg/l (BCAS, 2000).

Treated or untreated textile dyeing effluents seriously affect water bodies of Saver, Ashulia, Dhamrai, Gazipur and Narshindi and Narayanganj (D.N.D Embankment). Most of textile and dyeing industries are located in these areas. Several Researchers have analyzed polluted water collecting from different water bodies of these areas. The study has produced figures from published reports (Sultana, 2003; Hannan *et al*., 2011) and shown in Fig. 4 and 5. Discharged effluents of Narshshindi are highly alkaline (Fig. 4) and surface water of DND area is highly polluted due to huge TDS content in effluents (Fig. 5).

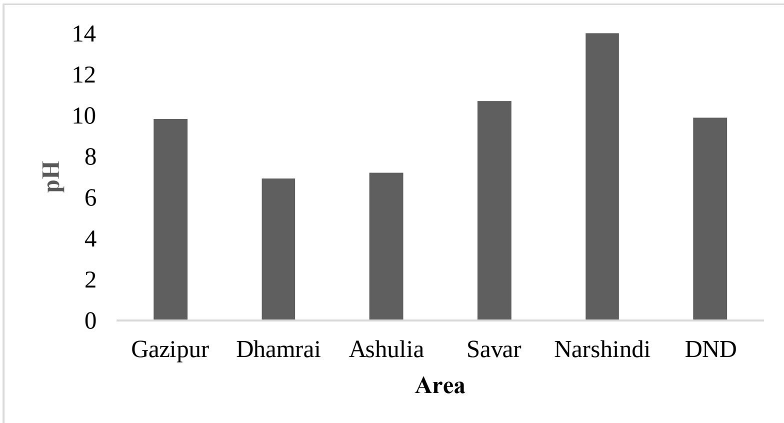


Fig. 4. pH of wastewater at different areas

Textile dyeing effluent indubitably affects the level of harvest production in the neighboring farming lands. The dye bath yield because of a great level of COD, BOD_5, and color toxicity surfactantôs, turbidity and at the similar period may enclose heavy metals. Discharge dyeing effluents affect soil quality. The plant height, tiller, and straw are affected by contaminated soil. The amounts of nutrients and their dissemination in different soil horizons are related to the growth progress of plantation. Several researchers analyzed contaminated soil of Narshindi Sadar at Narshindi district. They stated that the amount of N, P and K in contaminated soil are 0.461 micro g/g, 29.8 micro g /g and 1.786 where BRAC standards amount of N, P and K are 0.271-0.36 micro g/g, 22.30 micro g/g, 0.271-0.36 micro g/g in Narshindi and are 0.26%, 27% and 2.47% where fresh water contaminated soil contain 0.002% N, 0.28% P, and 9.43% K in Gazipur district, respectively. All of the nutrients are higher than BRAC standard due to the huge amount of textile dyeing effluent from different textile dyeing industrious. They also stated that among the study area 40% is highly polluted, 35% moderately, 20% less polluted and 5% non- polluted (Kanan *et al*., 2014; Begum *et al.*, 2011). On the basis of reviewed data on textile dyeing effluent it is found that contaminated soil of these textile industrial areas are not enough sufficient for farming. From the above discussion it is necessary to proper treatment of textile dyeing effluents before disposal due to environmental disturbance.

Treatment of textile dyeing effluents

Some environment protection agencies of the world have forced a set of laws entrusted through the shield of human health and guarding the environment from pollution caused by the textile dyeing effluents. These agencies forced several restrictions on the clearance of effluents into the environment (Table 2, 3 and 4). The effluents discharge standards are found to vary from country to country. The treatment of textile dyeing effluents has to follow the discharge standards. It is involved in three treatment processes namely primary, secondary and tertiary. Suspended solids, excessive quantities of oil and grease and gritty materials of the effluents are removed by Primary treatment (Eswara Moorthi *et al.*, 2008). The reduction of the BOD, phenol and oil contents and to control of color in the effluents is done by the secondary treatment under aerobic or anaerobic conditions. There are few technologies applied in tertiary treatments such as electro dialysis, reverse osmosis and ion exchange. Effluents discharged from the textile dyeing industries go through different physicochemical treatments such as flocculation, coagulation, adsorption, ozonation and advanced oxidation process (Adin and Asano, 1998).

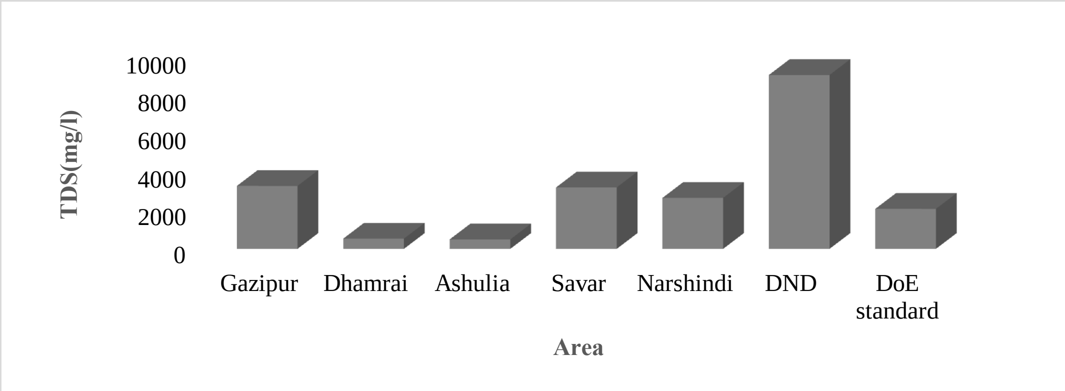


Fig. 5. A column diagram of maximum values of TDS (mg/L) of wastewater of different areas

Major challenges

Textile and dyeing industrious are very important in the development of the Bangladesh economy. However, the industry faces many challenges in maintain the sustainable development in Bangladesh as well as the other south Asian countries. Most of the textile and dyeing industries have no effluent treatment plants (ETP). Although few industries have an ETP, they do not operate regularly or use occasionally. Moreover, ETP produces huge sludge that creates another problem for the industry. Other challenges of textile and dyeing industries including lack of environmental awareness, research, technology, skilled, and the industrial owners' self-centered attitude are the main barriers to develop eco-friendly effluent management in textile dyeing industry. The poorly monitoring of the relevant departments of the country, e.g., DoE (Department of Environment) in Bangladesh and lack or no government subsidy for setting an ETP has further aggravated the situation. The challenges are being addressed with vigor and the forced opening up of the economy and gradual removal of the barriers.

Conclusions

The textile and dyeing industry is one of the major industries in the world. It offers employment and plays a foremost responsibility in the economy of many countries like Bangladesh, India, Pakistan, and Sri Lanka. A wide variety of synthetic dyes like azo dye, vat, reactive dye, disperse dye, etc. widely used in the textile sector. The textile dyeing industries produce large amounts of effluents, dirt slurry and solid waste ingredients every day. A complex mixture of dangerous chemicals both organic and inorganic discharges into the aquatic bodies from all these industries. About 40,000 m^3/day textile effluents and 26,000 Pollution load (BOD_5 kg/day) are discharged by these industries in Bangladesh. The pollutants are dissolved solids (DS), suspended solids (SS), colored compounds, higher BOD_5, COD, heavy metals, oily and slightly alkaline. Most of the parameters of the effluents exceed the limits of their standard set by different organizations. The higher values of COD, TDS, TSS, and EC indicate the stronger toxicity of the effluents. The dyeing industrial effluents cause of variation of the physical, chemical, and biological nature of aquatic atmosphere by the nonstop alteration in turbidity, odor, noise, temperature, pH, etc. The textile dyeing effluents are holding traces of metals, which are proficient of damaging the water, soil, and human health. The study found that the ecological balance of the rivers including Burigonga, Turag, and Shitalakkhya in Bangladesh are declined due to the discharging untreated effluents. The textile dyeing effluent severely affects crop production in the adjacent farming lands. The study observed that a few industries have an ETP, but the efficiency of the EPT has not enough to maintain the standard discharge limit. The study illustrated that the ETPs run using some common treatment methods including flocculation, coagulation, adsorption, ozonation, and advanced oxidation process. However, a single treatment unit cannot remove all the toxic organic and inorganic pollutants from the effluent and thus need to set a series of treatment units. The study observed that the toxic textile dyeing effluents are needed to treat before discharging into water bodies to reduce pollution.

Moreover, further research has to be continued for increasing the efficiency of the ETPs to reduce pollution and thus helps to build sustainable effluent management.

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