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# Selected Industrial Wastewater and the Human Health Concern: Reviewing the Context of Bangladesh

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## Abstract

Due to the discharge of untreated wastewater, Bangladesh's textile and tannery industries are responsible for polluting the soil and adjacent water bodies and finally effects on human health. They produce a complex mixture of organic and inorganic pollutants as well as metal contents during the processing of textile and leather goods, which has a detrimental effect on the environment. They also require vast amounts of water, chemicals, and colorants. Reviewing the various textile and leather dyes used in industrial processes and how they affect environmental contamination especially human health in Bangladesh was the goal of the study. The article was written to gather all current information on the characterization of textile and tannery wastewater from various publications, books, reports, and websites. The study demonstrated that the wastewater of textile and tannery industries has remarkably high biological oxygen demand, chemical oxygen demand, total dissolved solids, total suspended solids, electrical conductivity, and Cr level compared to the DoE discharge limit. Additionally, it was shown that tannery wastewater, which has higher Cr metal levels than textile dyeing wastewater, has a more severe adverse effect on community human health. The findings of the review study will assist in addressing this alarming condition in Bangladesh's ecology and will suggest quick action to protect the environment,

especially community health from untreated discharges of industrial effluents and build sustainable industrial wastewater management in Bangladesh.

**Keywords:** Public health, Tannery, Textile Industry, Water pollution, Wastewater

## INTRODUCTION

The disposal of industrial wastewater has become a significant issue in Bangladesh as a result of the country's fast industrial growth over the past three periods (Rabbi *et al.* 2016). The regular water consumption of the textile and Tannery sectors, among other types of industries, results in the production of a lot of industrial wastewater, which is full of harmful trace elements and diverse organic and inorganic compounds (Castillo *et al.* 1999). These wastewaters are typically dumped right next to landfills or into local lakes, rivers, or agricultural fields without any treatment (Das *et al.* 2010). Given that Bangladesh is the second-largest producer of ready-made clothing in the world, the textile sector is one of Bangladesh's two main users of water. Given that they contain a variety of synthetic dyes, heavy metal salts, and inorganic compounds, textile effluents are very hazardous and carcinogenic (Kabir *et al.* 2019; Islam *et al.* 2023; Hasan *et al.* 2014; Islam *et al.* 2018). Since the majority of textile manufacturers are not interested in discharging wastewater after sufficient treatment, textile wastewater is the primary cause of water pollution in surface and river water (Islam and Mostafa 2018; Haq and Clark 2013). The Department of Environment (DoE) requires every textile sector in the nation to install an effluent treatment plant (ETP). The effluent treatment plant is therefore a requirement in order to obtain DOE approval for the building of a plant in the nation. More than fifty percent of Bangladesh's current export-oriented sectors have set up ETP facilities, DoE claims, while the remaining companies have not done so as of yet (Islam and Mostafa 2022; Begum *et al.* 2020). However, smaller industries, such as those focused on the neighborhood market, cannot afford to build a quality ETP plant (Pérez-González *et al.* 2012). Because of this, all of those factories release their wastes into the water body immediately Even though many companies had adequate ETP facilities, they retained their ETP just to show to customers and to be in a secure position while under DoE monitoring (Gale 2006). On the other hand, a lot of industries (mid to big size) use cutting-edge ETPs and always use them (Haq and Clark 2013). The management of such industries is dedicated to protecting the environment and upholding DoE standards. Most of the time, these companies produce waste that is even higher quality than what the law mandates (Islam *et al.* 2012). In contrast, Bangladesh's tannery industry ranks second in terms of industrial pollution in the textile sector (Sarker *et al.* 2015). Chemicals are widely used in the tannery industry to turn animal hides into Tannery (Islam et al. 2023; Tadesse and Guya 2017; Islam et al.

2012). About 90% of tannery industries in Bangladesh use the chrome tanning method, which enhances the Tannery's qualities. Therefore, the production of Tannery goods also uses a lot of water and produces wastewater from the water used (Casseno *et al.* 2001; Hossian *et al.* 2017). Due to the abundance of brightly colored chemicals, poisonous metallic compounds, numerous organic and inorganic pollutants, various tanning ingredients, and significant amounts of suspended particles, these Tannery effluents contain severe pollution loads (Islam *et al.* 2023: Ghaly *et al.* 2014). As a result, both the effluents from the textile and Tannery industries pose the greatest risk to the environment and aquatic life (Chowdhury *et al.* 2015; Hasan *et al.* 2021). Therefore, industrial pollution from effluents is a significant environmental concern and one of Bangladesh's biggest issues right now (Hossain *et al.* 2017; Hasan *et al.* 2015).

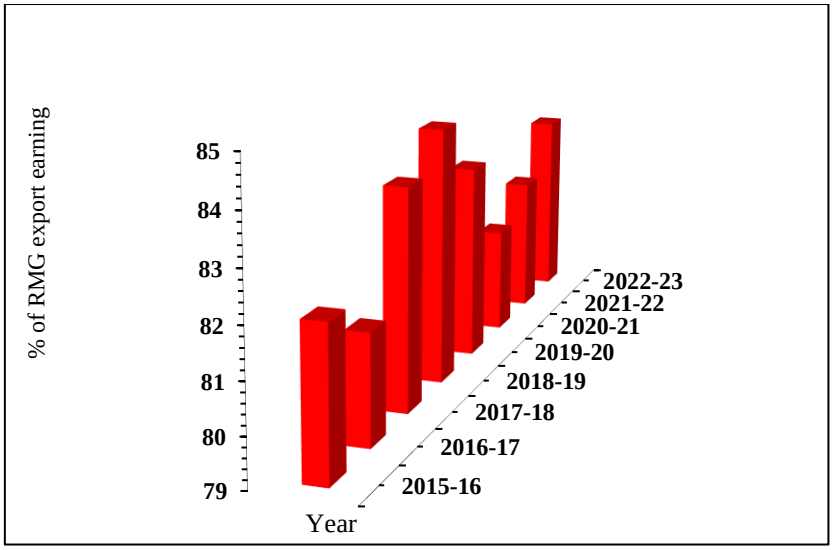


**Fig. 1.** Export earnings from RMG industries of Bangladesh (www.bgmea.com.bd)

Industrial effluents contain colorants and compounds that are not only harmful to humans but also have been documented to cause cancer. to be hazardous to aquatic life (WHO 2002), posing dangers to maintaining aquatic biodiversity, and producing serious environmental issues (Lellis *et al.* 2019). Although textile and tannery industries have a bad impact on the environment these industries provide jobs and have a significant impact on the countries' economy of Bangladesh. One figure of the RMG sector (Fig.1) has been made on export earnings from the RMG industries of Bangladesh. A figure (Fig. 2) has been made based on export earnings from the Tannery and Tannery products of the fiscal year 2015-2016 to 2019-2020 (Islam *et al.* 2023) and 2022-23 (www.worldfootwear.com). The article has been reviewed to gather the current status of textile and tannery wastewater and its effect on human health concerns in Bangladesh.

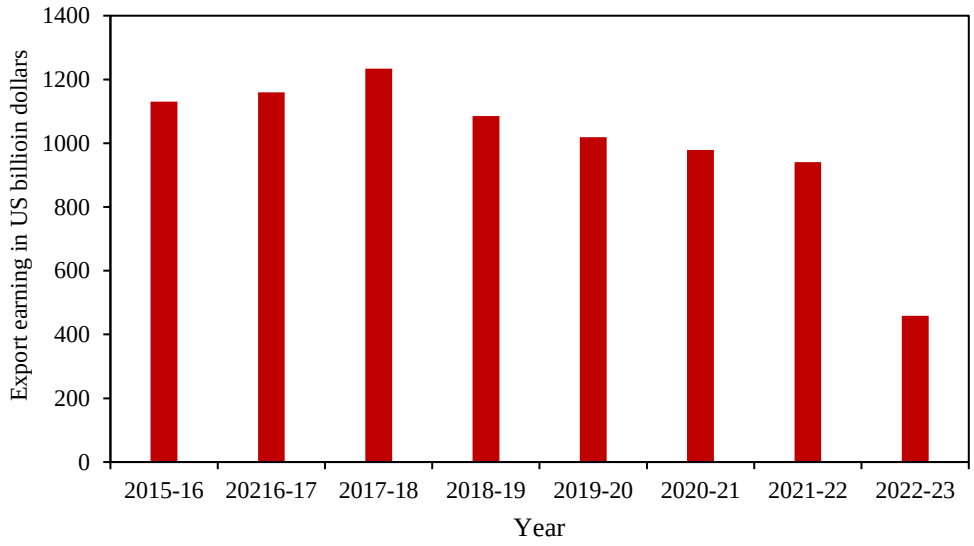


**Fig. 2.** Export earnings from the leather industries of Bangladesh

## METHODS

This review article was made to gather accessible information on Bangladesh's physicochemical nature of industrial wastewater specially tannery and textile industry. The article was prepared to compile all present data from different journals, books, reports, and web sources on textile and tannery wastewater characterization in the country. This composition suggests a thorough explanation of Bangladesh's industrial wastewater (Tannery and textile) characteristics as well as an impact on the human health of the community that is heavily dependent on the tannery and textile industry.

## DISCUSSION

### Application of dyes

On paper, Tannery, fur, hair, pharmaceuticals, cosmetics, waxes, greases, plastics, and textile materials, dyes are frequently used. The textile industry has utilized a wide range of dyes. The majority of dyes are used in synthetic fibers like nylon and natural fibers like silk and wool (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 penalizable aliphatic groups. The side groups attached impart the color to the dye (Ghaly *et al.* 2014).

**Source of Industrial Pollutants**

Pretreatment, dyeing, printing, and finishing are all steps in the printing and dying of textiles. Numerous substances including starch, waxes, Carboxyl Methyl Cellulose (CMC), polyvinyl alcohol, wetting agents, NaOCl, Chlorine, NaOH, $Na_2SiO_3$, Hydrogen per Oxide, acids, surfactants, $Na_3PO_4$, and short cotton fiber are present in the huge volumes of wastes produced by these operations. The methods used in textile printing and dyeing produce the possible particular contaminants. The contaminants are greasy, slightly alkaline, highly pigmented, high BOD5, dissolved solids (DS) of starch, low SS, and heavy metals (Ghaly *et al.* 2014).

The process of tanning, which transforms the derma, epidermis, and flesh into a solid, putrescible substance known as Tannery, takes place during the manufacture of Tannery. After being beaten, raw hides and skin are cleaned of filth, blood, or other debris, and then preserved with various types of inorganic salt until they are taken to the tannery. To remove as much salt as possible, hide and skin are generally cleaned readily by hand or occasionally mechanically in tanneries. Then, this hide and skin will go through a number of procedures. Toxins from the tanning process, including decomposing organic materials, sulfide, hair, lime, and organic nitrogen with high BOD and COD, complicate the process (Chowdhury *et al.* 2015). About one hundred and seventy different types of chemicals are used in the tanning process, including sodium chloride (NaCl) salt, fat, sodium chlorite, sulphuric acid ($H_2SO_4$), lime (CaO), ammonium, sodium sulfate, chromium sulfate, non-ionic wetting agents, soda ash, ammonium sulfate, bactericides, calcium oxide, ammonium chloride, formic acid, formal (Lokhande *et al.* 2011; Awulachew 2021; Sawyer and McCarty 1978). Table 4 (Hannan *et al.* 2011) provides a ranking of the pollution index according to its creation.

**Physicochemical nature of the industrial effluents**

Tannery is made by a variety of methods that combine different colors and auxiliary chemicals like acids, alkalis, fixing agents, etc. Tannery is dyed using mostly synthetic colorants. The typical characteristics of Tannery manufacturing effluent were its dark color, low pH, high EC, high BOD, high COD, high loads of total suspended solids (TSS), and total dissolved solids (TDS). Here is a brief discussion of some of the key aspects of tannery industry effluents. Table 1 below lists the average concentration of contaminants in Tannery industrial effluents from several Bangladeshi industries. Due to the extensive usage of lime and $Na_2S$ in Bangladesh's Tannery industries, the study indicated that the nature of the industry's effluents is alkaline (Table 1). The effluent's

EC was discovered to be more than the standard value (1100 S/cm) of ISW-BDS-ECR (1997), with values ranging from 1100 to 42500 S/cm.

**Table 1.** Physicochemical nature of the tannery wastewater

| Industry | EC($\mu$S/cm) | TSS (mg/L) | TDS (mg/L) | BOD (mg/L) | COD (mg/L) | Reference |
|---|---|---|---|---|---|---|
| Effluent (CETP) Savar | 1045 | 209 | 6486 | 97.5 | 337 | Munira *et al.* 2023 |
| RMM | 42500 | 1250 | 21300 | 4464 | 12840 | Jahan *et al.* 2014 |
| Mukti | 6500 | 1250 | 2910 | 190 | 550 | Rouf *et al.* 2013 |
| Ruma | 9000 | 1400 | 3300 | 400 | 1000 | Rouf *et al.* 2013 |
| Dhaka skin and hide | 1300 | 1600 | 3700 | 700 | 1700 | Rouf *et al.* 2013 |
| Karim | 19000 | 6080 | 14500 | 1200 | 10160 | Chowdhury, 2013 |
| ISW-BDS-ECR (1997) | 1000 | 500 | 2100 | 250 | 500 | Chowdhury *et al.* 2015 |

The most complicated wet process is dyeing, which uses hundreds of different dyes as well as auxiliary chemicals like fixing agents, acids, alkalis, etc. in the textile industries. Synthetic dyes are mostly used for the dyeing process. Only the dyeing process produces the majority of the effluent, which is around half of the entire amount. Generally, dyeing effluent is distinguished by its dark hue, high BOD5, COD, suspended particles, and dissolved solids. The physical and chemical characteristics of textile dyeing effluents from several industrial sites in Bangladesh are shown in Table 2. The study showed that the excessive use of bleaching powder in the Bangladeshi industry has resulted in the alkaline character of textile dyeing effluents (Table 2). The textile dyeing effluent's EC was determined to be greater than the standard limit (1200 S/cm) set by DoE (2008), ranging from 250 to 7950 S/cm. The increased EC suggests that there are many ionic compounds in Bangladesh's textile effluent (Table 2) (Roy *et al.* 2010). BOD and COD levels were often greater than acceptable discharge limits. The effluents' contamination intensity is shown by the increased BOD values.

**Table 2.** Physicochemical nature of textile industrial wastewater

| Area | pH | Temp (°C) | EC (µs/cm) | TDS (mg/l) | $BOD_5$ (mg/l) | COD (mg/l) | Ref. |
|---|---|---|---|---|---|---|---|
| Dhaka | 8.7-10 | 37-65 | 250-7950 | 460-5981 | 90-460 | 508 | Kamal *et al.* 2016 |
| Chittagong | 8.9-11 | 25-55 | 1108-1907 | 685-1338 | 140-420 | 487-1120 | Sultana *et al.* 2013 |
| Rajshahi | 6.70 | - | 4590 | 2937.5 | 117 | 340 | Islam and Mostafa, 2020 |
| Narayanganj | 6.8-11 | 50 | 592-1696 | 152-1011 | 60-450 | 268-1275 | Sultana *et al.* 2013 |
| Gazipur | 8.9-10 | 34.7-48.8 | 0.88-1701 | 531-1006 | 560-965 | - | Sultana *et al.* 2013; Hasan *et al.* 2011 |
| Narshindi | 5-14 | | 5640 | 127-2676 | 272 | 784 | Islam and Mostafa 2020 |
| DoE, standard, Bangladesh | 6.5-9 | 50 | 1200 | 2100 | 50 | 200 | Islam and Mostafa, 2018 |

The textile dyeing effluent's EC was determined to be greater than the standard limit (1200 S/cm) set by DoE (2008), ranging from 250 to 7950 S/cm. The increased EC suggests that there are many ionic compounds in Bangladesh's textile effluent (Table 2) (Roy *et al.* 2010). BOD and COD levels were often greater than acceptable discharge limits. The effluents' contamination intensity is shown by the increased BOD values. The presence of physiologically resistant organic elements and the hazardous condition are both indicated by the increased COD levels (Sawyer and McCarty, 1978). The considerable rise in COD levels when compared to BOD also suggests that there may be high quantities of harmful heavy metals in the effluents (Chavan, 2001). According to Uwidia and Ejeomo (2013), the TDS and TSS values were greater (Table 2), reflecting the increased oxygen levels needed to create the organic and inorganic particles found in the textile dyeing effluents. In Bangladesh, the comparison of dye effluent discharge from different industries is given below in Figure (3).

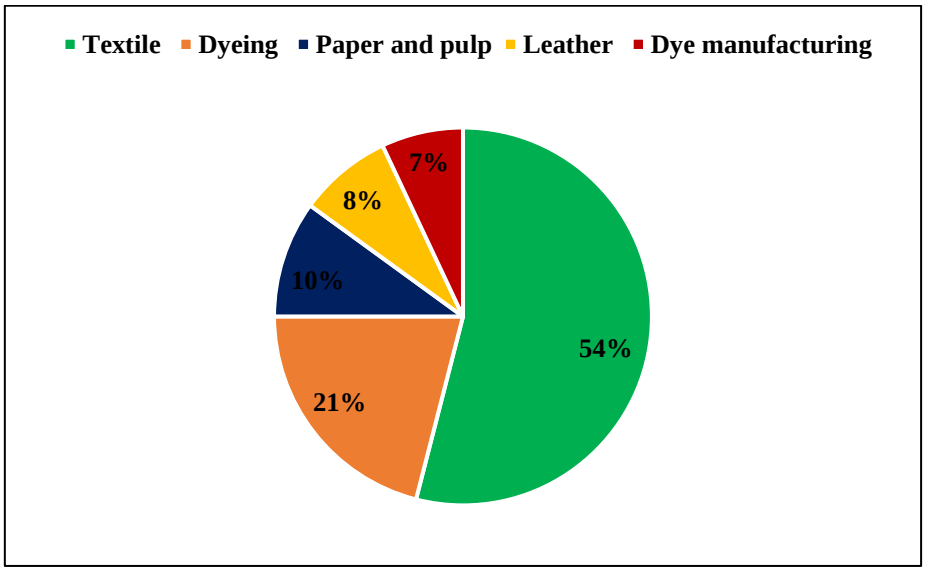


**Fig. 3.** Comparison of the wastewater discharge from different industries

**Heavy metals of selected industrial wastewater**

The concentration of heavy metals including Cr, Mn, Fe, Cu, Zn, and Pb in dyeing effluent samples is shown in Table 3. The concentrations of these heavy metals were lower than the national quality discharge standard limits for the textile dyeing effluents except for the concentration of Fe and Pb as stated by Dey and Islam (2012). it has shown that tannery wastewater, which has higher Cr metal levels than textile dyeing wastewater, has an adverse effect on the environment.

**Table 3.** The heavy metal concentration of the textile and Tannery wastewater

| Wastewater and standard | Concentration of heavy metals (mg/L) | | | | | | Reference |
|---|---|---|---|---|---|---|---|
| | Cr | Fe | Mn | Cu | Zn | Pb | |
| Tannery | 6.1 | 2.05±0.4 | 0.2±0.1 | 0.94±0.03 | 0.22±0.02 | 0.24±0.1 | Munira *et al.* 2023 |
| Textile | 0.1334 | 4.2826 | 0.1977 | 0.0479 | 0.2585 | 0.0621 | Islam and Mostafa, 2020 |
| DoE (1997) | 0.5 | 2.0 | 5.0 | 0.5 | 5.0 | 0.1 | Dey and Islam, 2015 |
| ISI (2000 | 0.1 | - | 2.0 | 3.0 | 1.0 | 0.2 | Munira *et al.* 2023 |

**Impact of wastewater on human health in Bangladesh**

In Bangladesh, there are several rivers and canals. The country receives 1000 to 5000 mm of rain every year, depending on the region. Each year, the Bay of Bengal's network of more than 200 major and minor rivers supplies it with over 175 billion cubic meters of water (BBS 2005). The nation's main water sources are the rivers Meghna, Brahmaputra, and Ganges. Bangladesh only makes up 8% of the 1.7 million square kilometer catchment area that feeds water to Bangladesh's rivers. Additionally, 2.4 billion tons of silt are transported annually by these rivers into the Bay of Bengal. Some of Bangladesh's well-known and well-managed industrial estates include Tongi, Konabari, and Gazipur (Kaliakoir) in the Dhaka division; Kalurghat, Foujdarhat, and Sholashahar Estate in Chittagong; Jessore and Shiromoni in Khulna; and Hosiery Estate in Narayangon. The North Central region is a hub for the majority of the country's industrial areas. About 33% of the industries in the North Carolina region are textile, finished clothing, and tanneries. About 32% of them are in Narayanganj, and 50% are in the Dhaka district (UNEPRRC AP 2001). The environment is being impacted by the recent, rapid industrialization, which may be due to inadequate planning and management. Untreated industrial waste discharge has an adverse effect on the environment and human health as well as surface water quality. For those who live close to industrial flashpoints like Kaliakoir in Gazipur, Hazaribag in Dhaka, Kalurghat in Chittagong, Shiromony in Khulna, etc., this means that pollution from industry has become a more significant element influencing human health. The North Central region is home to the majority of the country's industrial areas. Tanneries, finished garments, and textiles make up around 33% of the industries in the North region. Over a thousand polluting industries have been identified by the government of Bangladesh's Department of Environment (DoE), with more than half of them located in the Dhaka area. None of the aforementioned industries have access to wastewater treatment facilities. As a result, the untreated effluents and contaminants end up in the nearby ponds, lakes, canals, and rivers like Burigonga, Turag, and Shitalakkhya. In the end, this affects people's health, especially those who reside nearby. The DoE has identified 1176 big polluting businesses based on industry categories (Fig 4). These companies are contaminating the nearby surface water, which has an impact on people's health in Bangladesh (Rabbani *et al.* 2009).

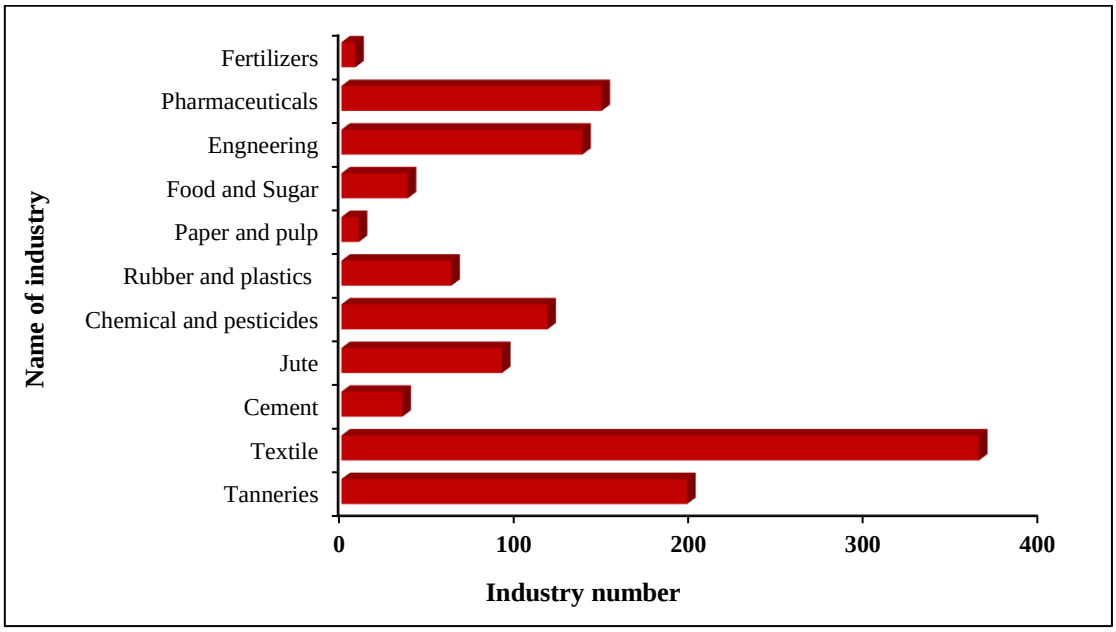


**Fig 4.** Total number of industries in Bangladesh

Using dyes and pigments in the textile and dyeing industries may have a negative impact on your health in a variety of ways (Fig. 5). Colorants, heavy metals, crease-resistance agents, antimicrobic agents, solvents, insecticides, and flame retardants are only a few of the many categories of chemical substances (Mahmud *et al.*, 2011). According to Malik and Khan (2013), almost 40% of colorants used worldwide have chlorine that is organically bonded and known to cause cancer.

**Fig 5.** Unhygienic process for thread dyeing done by the worker (photo by Rafiqul Islam)

Due to the toxic nature of the textile dyeing effluent, the normal functioning of cells is disrupted, which may change the physiology and biochemical mechanisms of animals and harm vital functions like respiration, osmoregulation, reproduction, and even mortality. Allergies can be brought on by textiles (Fig. 6). It was discovered that extended exposure to reactive dyes caused employees to develop dermatitis, asthma, nasal issues, and rhinitis.

**Fig 6.** A man showed affected skin by Textile wastewater (Photo by Rafiqul Islam)

The Tannery industries in Bangladesh that engage in tanning endeavors are the ones that cause the greatest pollution. Due to its extensive capacity for contamination, it is often regarded as a "dirty industry" throughout the whole world. Significant metals are the most valued component among the various biological and inorganic wastes removed from tanneries, and among the dangerous irresistible metals, chromium (Cr-VI) is the most notable. Chromium, a poisonous and seductive metal used in tanneries in Hazaribagh, is discharged straight into the Buriganga and has been linked to cancer, genetic disorders, and birth defects if it enters the food chain. Over one lakh eighty thousand people derive their drinking water from a river from which Tannery effluents were dumped directly. In a filthy and extremely dangerous environment, the fifteen thousand employees and residents who lived nearby were constantly exposed to harmful compounds (Islam 2022; Islam *et al.* 2023). Chromium can keep itself in or pass through human tissue, or it can function precisely at the point of contact. Workers in the Tannery industry frequently come into contact with a dangerous combination of

chemicals while measuring, combining, adding them to hides in containers, or utilizing hides that have been soaked in them, which can lead to a variety of health issues like skin and lung ailments. Some chemicals, such as $H_2SO_4$ and $Na_2S$, which may burn human tissues, the skin, and the respiratory system, can cause short-term health problems. Other substances, such as pentachlorophenol, azo colorants, and HCHO, are known or suspected human carcinogens; nevertheless, the consequences on health may not become evident right away. Former and current tannery workers expressed and displayed a variety of health issues, including early aging, itchy, fading, cracking, acid burnt, and rash-covered skin; fingers that had rusted to stumps; pains, dizziness, and nausea; and mutilated or severed limbs. Although Human Rights Watch is unaware of any epidemiological findings about cancer among Bangladeshi Tannery industry workers, some shaky data suggests that cancer rates are undoubtedly higher among those who work with chemicals (www.hrw.org). The most obvious reaction to chromium's interaction with skin is disapprovingly sensitive contact dermatitis. According to research published by the Bangladesh Society for Environment and Human Development, 0.5 million people living in Dhaka, the 10th largest city in Bangladesh, are in danger of developing major health problems as a result of chemical contamination from tanneries close to their houses.

**Fig 7.** File photo of Savar Lather Industrial Estate Mehedi Hasan/Dhaka Tribune

According to the research, 90% of the 8000–12000 workers at the tanneries pass away before the age of 50, compared to 60% of the country as a whole, and many of their gastrointestinal, dermatological, and other illnesses may be linked to pollution. According to a 2012 Human Rights Watch report on the health effects of Tannery tanneries, Hazaribagh residents reported 30% more cases of skin diseases, 20% more

cases of jaundice, and 16% more cases of kidney-related disease compared to residents of a comparable neighborhood farther away from the tanneries (Al-Muti, 2017). Three people (Fig. 7) were working in the unhygienic environment at Svar leather estate (www.arearchive.dhakatribune.com). Workers stand knee-deep without any protective clothing in tanning water as they transfer rawhides into another tank (Fig. 8) just this past March, three workers died of chemical inhalation

**Table 4.** Ranking of the pollution index

| Industry | Water pollution | Pollution product | Ranking |
|---|---|---|---|
| Textile | Big | 3.35 | 1 |
| Tannery | Extreme | 1.88 | 2 |
| Sugar | Extreme | 1.72 | 2 |
| Agriculture | Moderate | 1.08 | 3 |
| Paper | Very big | 0.67 | 4 |
| construction | Small | 0.14 | 5 |
| Transport | Small | 0.02 | 6 |

The Dhaleshwari River has been condemned by the local community for becoming "unusable" and "toxic" after the tanneries came and regularly dumped untreated industrial effluents from the Tannery industry (Shadat *et al.* 2020). The lives of the low-income riverside residents have been hampered by the pollution of the Banshi and Dhaleshwari rivers. The air is also becoming increasingly pungent with garbage.

**Fig 8.** A man works in the Tannery processing section without any protection

The ecology in the area is at risk. By utilizing polluted water, many individuals are developing respiratory and skin conditions. The residents at Saver are finding it harder and harder to survive across the river.

## CONCLUSION

One of the largest industries in the world is the textile and tannery industrial sector. These industries provide jobs and have a significant impact on the countries' economy of Bangladesh. Every day, the textile and tannery industries generate significant amounts of solid waste, dirt slurry, and wastewater Bangladesh's poisonous and hazardous tannery and textile wastewater pollution is a significant social and environmental issue. The review study depicted enormously high values of TSS, EC, pH, TSS, TDS, BOD, and COD in several textile and tannery wastewater. The values of the wastewater parameters surpassed the standard permissible limits for DoE in Bangladesh. The study also exposed that the content of toxic metals such as Cr exceeded far above the standard, especially in the tannery industries. The textile and tannery wastewater are holding traces of metals, which are proficient in damaging the environment and human health. The study found that the ecological balance of the rivers including Buriganga, Banshi, Turag, Dhaleshwari, and Shitalakkhya in Bangladesh declined due to the discharging of untreated effluents. The study observed that the toxic tannery wastewater is needed to treat before discharging into water bodies to reduce pollution.

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