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Characterization and Removal Efficiency of Central Effluent Treatment Plant (CETP)

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Abstract: Tannery industries are one of the most pollution-generating industries in the world. Tannery wastewater is usually characterized by high BOD, COD, TDS, and TSS and a high percentage of dissolved organic and inorganic matter. The central effluent treatment plant (CETP) of industry plays a vital role in sustainable industrial waste management and saves different lives from harmful effects. The study aimed to analyze various physicochemical parameters of the composite tannery influent and effluent as well as the removal efficiency of the CETP of the Savar Tannery Industrial Zone in Bangladesh. It was carried out at Savar Upazila, situated in the northwest part of Dhaka, Bangladesh. The samples were collected three times (pre-monsoon, monsoon, and post-monsoon) in a year, from monsoon 2021 to pre-monsoon 2022. The major water quality parameters for the influents and effluents included pH, BOD, COD, TDS, TSS, NO_3^-, SO_4^{2-}, HCO_3^-, PO_4^{3-}, Cl^-, Na, Ca, Cr, Fe, Cu, Zn, and Pb. Most of the parameters, especially BOD, COD, TDS, and TSS after treatment, exceeded the standard permissible limits of effluent discharge prescribed by the ISW-BDS-ECR (1997), DoE-BD, and NEQS (2000), and these values were two times higher than the permissible limit. The DO value was four times lower than the permissible limit, indicating heavily polluted water. The concentration of the cations in the tannery effluents was in the following order: Na>Ca>Cr>Fe>Cu>Zn>Pb. The analysis results illustrated that the overall removal efficiency of the CETP was about 47%. The study observed that the performance of the CETP was not satisfactory, and hence it needs further improvement in the treating capacity for sustainable industrial wastewater management.

Keywords: *CETP, Efficiency, Effluent, Influent, Tannery*

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1. Introduction

Rapid industrialization and urbanization, particularly in developing nations, have increased awareness of the connection between pollution, public health, and the environment (WHO, 1982). Industries produce a lot of effluents, depending on the type of industry, and may contain a variety of hazardous compounds, including acids, bases, metals, organic pollutants, and inorganic pollutants (Islam and Mostafa 2018). The most water-intensive industries in the world are leather, pulp, and paper mills, fertilizer, textile and dyeing, sugar, chemicals, and petroleum refineries (Shakil and Mostafa 2021; Rahim and Mostafa, 2021 and Mostafa 2018). Lower and upper-middle-income countries, like Bangladesh, India, Pakistan, China, Brazil, and Ethiopia rely heavily on their leather industries (Chowdhury et al. 2013). At present, the leather Industry is one of the most polluting industries in Bangladesh. The leather industry wastewater is characterized by its high BOD, high COD, total dissolved solids, total suspended solids, and a high percentage of dissolved organic and inorganic matter (Akan et al. 2009; Monira and Mostafa 2022). So, this untreated wastewater will create problems for the environment. The purity, beauty, attractiveness, and sustainability of the environment are primarily affected by population growth and industrialization (Islam and Mostafa 2022). The quality of soil, surface water, and groundwater has systematically deteriorated by the release of untreated or not properly treated industrial effluents into the ecosystem (Islam and Mostafa 2020). The environment is threatened by the entry of numerous contaminants such as heavy metals and other organic and inorganic hazardous components in soil, surface water, and groundwater aquifers (Shakil and Mostafa 2020; Islam and Mostafa

2021). Untreated wastewater must be treated before discharging into the environment. In this context, an effective effluent treatment plant plays an important role in maintaining surface water quality as well as the environment. Generally, a Common effluent treatment plant (CETP) is designed to help industries in easier control of pollution and develop a step towards a cleaner environment and service to the industrial sector at a large scale. For, this reason, an efficient effluent treatment plant is necessary for its liquid waste management. The Central treatment plant (CETP) has been established in the Savar tannery estate as an alternative to Hazaribagh tanneries located in Dhaka City, aimed to reduce pollution of the river Buriganga and the nearby areas of the city.

Old Hazaribagh tanneries were first seriously considered for relocation in the 1990s, and the Bangladeshi government then developed a policy for relocation in 2001. However, the government's allocation of land for 155 tanneries in the Tannery Industrial Estate in Savar could potentially lead to the initiation of the relocation process in early 2014. When the government decided to cut off the utilities to their former establishments in Hazaribagh in April 2017, the majority of tanneries were forced to relocate their factories. According to a recent report by BSCIC (April 2019), out of the 155 industries, 123 have already begun processing the leather at the newly established tannery estates, while 18 are under construction.

Approximately 155 tannery industries have been transferred from Hazaribagh, Dhaka to the Savar Tannery Estate at Hemayetpur to save the Buriganga river from further pollution, and around132 industries are active in the production of leather goods (BSCIC, 2019; Mollic and B.A, 2022). The industries discharge the effluents through a pipeline and they enter into the CETP for treatment after treatment they release from the CETP and fall into the Dhaleshwari river (Fig. 1).

According to Hasan et al. (2020), the Central Effluent Treatment Plant (CETP), which has a daily capacity to handle 30.000 m^3 of effluents, is the project's lifeline. Concerns about the efficient operation of CETP and other supporting elements like the dumping yard and chrome recovery unit in ensuring environmental compliance have consequently developed as a teething problem' of the relocation process. The current central effluent treatment plant at the Savar estate, according to Department of Environment sources, has the capacity to process about 25,000 cubic meters of liquid waste per day. But 40,000 cubic meters of waste are produced by the tanners inside the estate. The warning, which asserts that 15,000 cubic meters of untreated waste are currently being dumped into the nearby Dhaleshwari river, is quite depressing. Heavy metals and chromium, which are also discharged into the river, cannot be treated in the exclusive tannery zone because there is no existing structure for that purpose. All of these things combine to make the Hemayetpur section of the river a source of open pollution. So, the efficiency of Savar CETP is questionable. Ghosh P and Hossain M (2019) carried out works on tannery influents and effluents, Hasan et al (2020) carried out work on CETP effluents and surface water quality of the Dhaleshwari river, Tisha et al (2020) assess only soil and Vegetable around CETP zone but as for now, there is no details work on the assessment of CETP performance at Savar tannery estate in the northwest part of Dhaka city in Bangladesh are available. The aim of this paper is to characterize the influent and effluent of the CETP and asses its performance of the CETP.

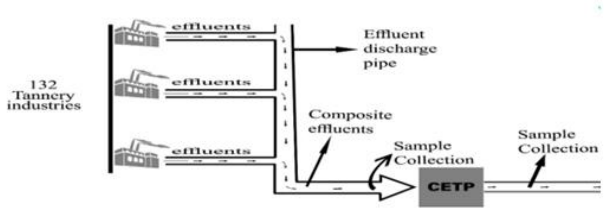

Figure 1: Sample collection area at Savar tannery estate

2. Materials and methods

The study area was located in the tannery industrial zone in Savar Upazila, situated in the northwest part of Dhaka city, Bangladesh. It is located at 23°51′30″N 90°16′ 00″E / 23.8583°N 90.2667°E / 23.8583; 90.2667. Fig. 2 shows the sampling location of the study area.

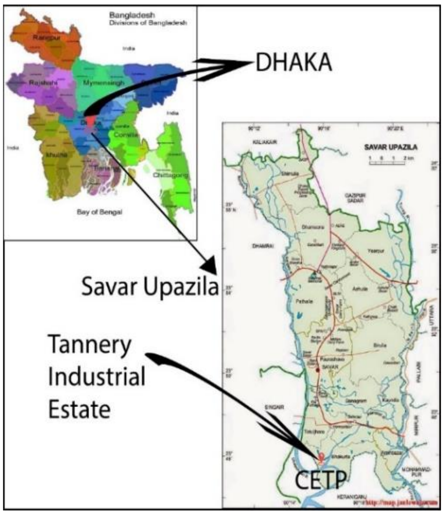

Fig 2: Location map of the study area

Sample collection

Composite effluents were collected from the main drain before entering the CETP and after the treatment from CETP at Savar Tannery Industrial Estate in Bangladesh and analyzed for various physicochemical parameters. These industries generated numerous tannery effluents that must need proper treatment. The study was conducted from September 2021 to March 2022, and the samples were collected three times over three months intervals during this period. A composite mixture of the tannery industry's effluents was collected before entering into the CETP and after the treatment from the CETP just before falling into the Dhaleshwari river (Fig.1). Sterilized plastic bottles (500 ml) and polyethylene bags were used to collect the effluents. The samples were kept in ice boxes and taken to the laboratory for analyses of several physicochemical and anionic parameters. One ml of concentrated HNO3 (65%) was poured into each sample bottle and stirred well to keep the pH below 2 and minimize the precipitation and adsorption on the wall of the bottles to determine the cationic concentrations. But the samples were collected in a separate bottle without adding the HNO3 for the analysis of the physicochemical and anionic parameters.

Characteristics of Tannery influent and Effluent

The collected influent and effluent samples were analyzed for various physicochemical parameters like pH, electrical conductivity (EC), total suspended solids (TSS), total dissolved solids (TDS), biological oxygen demand (BOD_5), and chemical oxygen demand (COD). pH and EC values were measured on the spot using a portable digital pH meter (Model KRK, KP-5z, Japan) and a digital multi-range conductivity meter (Model Hanna HI 9033, Singapore). TSS and TDS were measured gravimetrically following standard methods in the research lab (APHA, 2005). The DO, BOD_5, COD, $Cl^{-,}$ bicarbonate (HCO_3^-), hardness, sulfate (SO_4^{2}-), and phosphate (PO_4^{3}-) were determined by standard methods (APHA-AWWA-WPCF,2005) of analysis in the research laboratory.

The concentrations of Na, Ca, Zn, Cu, Fe, Pb, and Cr ions in the wastewater were estimated by the AAS method following the digestion of the samples with concentrated HNO_3 and HCl mixer in the ratio of 1:2 (APHA, 2005) in the central science lab of Rajshahi university. All the used instruments were calibrated with the standard solution before being used and the chemicals used were of analytical grade. Experiments were performed at least three times to avoid analytical errors. The results were compared with effluent discharge limit values of the Department of Environment, Bangladesh (DoE-BD, 1997), National Environmental Quality Standards (NEQS 2000, BD), and Inland Surface Water-Bangladesh Standards (ISW-BDS-ECR 1997).

The removal efficiency of the CETP

The efficiency was determined by using this formula.

Removal efficiency % = $\frac{\text{Inlet effluent} - \text{Treated Outlet effluent}}{\text{Inlet effluent}}$ ×100

3. Results and discussion

3.1. Physicochemical characterization of influent and effluent samples

The tannery industrial influent and effluent of the Savar tannery estate were analyzed to determine the concentration of some major physicochemical parameters. The analyzed parameters namely pH, TDS, TSS, EC, hardness, DO, BOD_5, COD, Na, Ca, Cr, Cu, Zn, HCO_3-, Cl^-, NO_3-, SO_4^{2}-, and PO_4^{3}- etc. These physicochemical parameters represented the pollution status of the tannery influent and effluent. The analysis results of the physicochemical parameters of the influent and effluent are stated below.

pH and DO

The pH values in untreated and treated composite tannery effluents ranged from 6.9 to 8.9 and 6.6 to 8.3 with a mean of 8.2 and 7.4, respectively (Table 1). The mean value of influent and effluent pH was within the standard value of the discharge limit of the Department of Environment, Bangladesh (DoE-BD,1997), NQES, and ISW-BDS permissible limit for inland water. The alkaline nature of these composite tannery wastes was owing to the use of lime, Na_2CO_3, Na_2S, and NaOH during the rawhide and skin processing. The lowest and highest values of Dissolved Oxygen (DO) of the analyzed influent and effluent samples were 0.6 and 0.8 mg/L and .5 and 1.2 mg/L, respectively, with the mean concentration of 0.6 mg/L in the influent and .8 mg/L in the effluent, which are far below the standard prescribed limits set by the DoE-BD (1997), NEQS (2000) and ISW-BDS-ECR (1997).

The low DO values of the influent and effluent samples indicate a higher level of organic pollutants present in the composite influent and effluent, and also, the higher values of BOD_5 in the influent and effluent indicate the presence of organisms in the influent and effluent (Verma et al.2008). The DO value (<1 mg/L) indicated that the discharged composite influents and effluents were heavily polluted and potentially harmful to aquatic life.

EC, TDS, and TSS

The study results showed that the concentration of TDS ranged from 6367 to 7378 mg/L in the influent and 6405 to 6617 mg/L in the effluent. The input and output samples of CETP exceeded the standard permissible limits (2100 mg/L, DoE-BD,1997), indicating the presence of large amounts of dissolved solids. The mean TDS concentration was 6817 mg/L in the influent and 6486 mg/L in the effluent, which is almost double compared to the standard permissible limit, set by the (DoE-BD, and ISW-BDS-ECR, 1997). Rouf et al (2013) stated that the TDS concentration of the tannery effluents was 3455 mg/L in the sample’s sources from various points of the Hazaribagh tannery industrial zone, which was much lower than the TDS concentration of the present study. The TSS was 1486 to 1918 mg/L in the influent and 82 to 322 mg/L in the effluent with a mean value of 1756 mg/L and 209 mg/L respectively (Table 1). These values exceeded the prescribed permissible limit set by the DoE-BD,1997 (150 mg/L), indicating huge amounts of suspended solids present in the discharge influent and effluent. The higher values of TDS and TSS in the tannery waste were due to the presence of various organic and inorganic substances. The high levels of TDS and TSS in the influents and effluents indicated that the influents must be properly treated before discharging into the surface water bodies. The electrical conductivity values of the composite influent and effluent samples ranged from 10270 to 11900 μs/cm and 9300 to 12700 μs/cm respectively in the study period and almost showed higher EC as compared to the prescribed standard limit (1200 μS/cm, DoE-BD,1997; NEQS, 2000; 288 mg/L). Kabir et al (2007) reported that the EC values of the Hazaribagh tested tannery effluents area ranged from 587 to19000 µs/cm, which showed some similarity with the results of the present research work. The higher EC content indicates the existence of an adequate amount of organic and inorganic compounds and salts, mostly sodium and chromium salts used in the pickling and tanning procedures, which may boost the electrical conductivity of the effluent samples (Chowdhury et al. 2013). The average EC of all composite influent and effluent samples was far above the permissible limits, signifying a very poisonous environment for the aquatic biota.

Biological and chemical oxygen demand (BOD_5 and COD)

The values of BOD_5 in the influent and effluent samples were in the range of 508- 590 mg/L and 53-137 mg/L, respectively (Table 1). A maximum of 590 mg/L of BOD_5 was found in the influent of the Savar tannery industrial area. All the BOD_5 values of the tannery wastes obtained were higher than the discharge standard of tannery effluents (50 mg/L, DoE-BD). The high value of BOD_5 indicates the presence of a huge quantity of organic substances in the tannery wastes. The high content of organic ingredients consumed a huge quantity of O_2 and increases the level of BOD_5. A study conducted by Gosh and Hossain (2019) illustrated that the BOD_5 of the tannery wastes obtained was 160 mg/L, which was much lower than the present study findings, indicating that the pollution level is increasing day by day.

In the present study, the COD values at Savar were 1540, 1647, and 1750 mg/L in the influent and 312, 208, and 489 mg/L in the effluent, respectively (Table 1). An average value of COD observed was 1646 mg/L and 337 mg/L in the composite mixture of the influent and effluent discharged by the tannery industries, which is two to eight times higher than DoE-BD,1997 discharge standard limits. Jahan et al (2014) stated that the COD value of Hazaribagh tannery industrial wastes was 12840 mg/L, which is about seven times the present study results. The results also informed that the COD level at all monitoring tannery industries did not meet the standard discharge limit into inland surface water (permissible limit:200 mg/L, DoE-BD,1997). The COD level commonly indicates the concentration of organic and inorganic matter in wastewater that is not decomposed by microorganisms (Islam et al. 2014). Unproperly treated Effluents released into aquatic ecosystems change the pH and increase the BOD_5 and COD. So, the tannery effluents should be properly treated before being discharged into adjacent water bodies.

Total Hardness

The total hardness of the study ranged from 350 to 1470 mg/L in the influent and 635 to 730 mg/L in the composite tannery effluents during the study period (Table 1). The highest total hardness observed was 1470 mg/L in the discharge effluents. Gosh and Hossain (2019) illustrated that the total hardness of the tannery effluents for the same industrial estate was 490 mg/L, which was much lower than in the present study. The higher content of total hardness indicates the high content of carbonate and bicarbonate and specifies the existence of higher levels of liquified salts (Bosnic et al., 2000).

Anionic parameters

The average value of chloride (Cl^-) concentration in the influent and effluent of the Savar tannery industrial estate was found to be 2417 and 1667 mg/L, respectively during the study period. The incidence of a higher amount of chloride content in tannery wastes was due to adding the surplus quantity of NaCl for the preservation and pickling procedures of the raw skins and hides. Thus, it indicated a load on the surrounding environment (Saritha and Meikandaan, 2013). Hence, a higher value of chlorides in the composite wastes increased the chloride contamination of the adjacent water bodies.

The results of the present research showed that the concentration of phosphate, nitrate, sulfate, and bicarbonate ions in the tannery influent and effluent samples of the Savar tannery industrial area ranged from 26.6 to 29.6 mg/L in the influent and 6.9 to 7.5 mg/L in the effluent, 56-64 mg/L in the influent and 3.3 - 4.6 mg/L in the effluent, 1890- 1900 mg/L in the influent and, 1830 to 1910 mg/L in the effluent and 1050 -1300 mg/L in the influent and 100-730 in the effluent, respectively (Table 2). Whitehead et al. (2021) illustrated that the mean concentration of phosphate, nitrate, sulfate, and chloride of the tannery effluents in Bangladesh were 17.6, 61.7, 2783.6, and 6631.7 mg/L, respectively, which show some similarities with the present study results. The values of phosphate, bicarbonate, nitrate, and sulfate of all influent and effluent samples of the tannery industrial estate exceeded the discharge limits set by the NEQS and DoE-BD. The higher content of sulfate in the composite tannery waste samples may also be the result of many auxiliary chemicals used in the industry.

Cationic parameters

Table 3 shows the concentration of metallic ions in the composite tannery influent and effluent collected from the input of CETP at the Savar tannery industrial area. The results show that the concentrations of metal ions ranged from Ca 185 to 238 mg/L in the influent and 85 to 95 mg/L in the effluent, Cr 75.6 to 85.8 mg/L in the influent, and 5.8 to 6.4 mg/L in the effluent, Na 1691 to 2000 mg/L in influent and 1647 to 1944 mg/L in the effluent, Zn 1.7 to 1.8 mg/L in the influent and .90 to .95 mg/L in the effluent, and Cu 1.7 to 1.8 mg/L in the influent and .90 to .95 mg/L in the effluent, Fe 2.5 to 2.9 mg/L in the influent and 1.9 to 2.7 mg/L in the effluent and Pb .28 to .39 mg/L in the influent and .18 to 2.9 mg/L in the effluent during the research period.

The higher content of Na ions in the influent might be owing to the NaCl salts used in skin and hide preservation and pickling procedures. The presence of Cr in the tannery wastes might be due to chrome-rich tannery wastewater samples. Several researchers reported similar results for metal ions in tannery wastes (Akan et al. 2009; Chowdhury et al. 2015). The content of metallic ions in the composite tannery effluents was in the following order: Na>Ca>Cr>Fe>Cu>Zn>Pb based on the mean values. Serious, health, and aquatic hazards are caused by metals released from the leather industry.

Copper is a common environmental metal and is essential in cellular metabolism but at high concentrations, it can be highly toxic to aquatic life (Grosell et al. 1997). It is an essential substance for human life, however, in high concentrations, it can cause anemia, kidney and liver damage, and stomach and intestinal irritation (Turnland, 1998). It is generally re-mobilized with an acid-base ion exchange or oxidation mechanism (Gomez et al. 2000). Long-term exposure to copper may lead to liver and kidney disorders (EPA, 1999). Zinc is also an important and helpful nutrient in the human diet. A lack of Zn in the diet may be more harmful to human health than an excess of it (ATSDR, 1994). However, Zn is highly toxic to many aquatic organisms in aquatic ecosystems. Although the above-mentioned Zn is not carcinogenic to humans, high doses can be fatal (ATSDR, 1994). Zinc is a helpful micronutrient for all organisms and serves as the active site for a variety of metalloenzymes (DWAF, 1996). Excessive Zn consumption can cause dehydration, vomiting, abdominal pain, nausea, lethargy, and dizziness (ATSDR, 1994). A high concentration of Ca is responsible for scale formation.

Table 1: Physicochemical Parameters of tannery Influent and Effluent.

Parameters*	Periods (Influent)				Periods (Effluent)			
	Sep 2021	Dec 2021	March 2022	Mean + SD	Sep 2021	Dec 2021	March 2022	Mean + SD
pH	6.9	8.9	8.9	8.2+1.15	7.4	6.6	8.3	7.4+.85
DO	0.6	0.8	0.6	0.6+.12	0.5	0.8	1.2	0.8+.35
EC (µs/cm)	11900	10820	10270	10996+829	12700	9300	10180	10727+1764
TDS	7378	6708	6367	6817+514	6437	6405	6617	6486+292
TSS	1866	1918	1486	1756+235	223	322	82	209+120
BOD	508	590	560	553+41.49	80	53	137	90+42.88
COD	1540	1647	1750	1646+105	312	208	489	337+142
Hardness	660	350	1470	827+578	635	730	672	679+48

*mg/L, except the pH and EC

Table 2: Anionic Parameters of tannery Influent and Effluent

Parameters (mg/L)	Periods (Influent)				Periods (Effluent)			
	Sep 2021	Dec 2021	March 2022	Mean + SD	Sep 2021	Dec 2021	March 2022	Mean + SD
HCO_3^-	1250	1050	1300	1200+132.29	115	100	730	315+359.5
PO_4^{3-}	26.6	28.70	29.6	28.3+1.54	7.5	7.1	6.9	7.2+.3
SO_4^{2-}	1910	1890	1900	1900+10	1870	1830	1850	1850+20
Cl^-	2350	2500	2400	2417+76.38	2510	1300	1190	1667+732.42
$N\text{-}NO_3^-$	56.2	60.1	64.25	60.18+4.03	3.25	4.65	4.1	4+.71

Table 3: Cationic Parameters of tannery Influent and Effluent

Parameters(mg/L)	Periods (Influent)				Periods (Effluent)			
	Sep 2021	Dec 2021	March 2022	Mean + SD	Sep 2021	Dec 2021	March 2022	Mean + SD
Na	1691	1960	2000	1884+168	1852	1647	1944	1815+152
Ca	185	232	238	218+29.02	87	85	95	89+5.29
Cu	1.7	1.7	1.8	1.7+.10	0.9	0.95	0.93	0.9+.03

Zn	1.7	1.7	1.8	1.7+.10	0.9	0.95	0.93	0.9+.03
Cr	75.6	85.8	80.9	80.84+5.10	5.8	6.3	6.4	6.1+.32
Fe	2.5	2.7	2.9	2.7+.2	1.9	2.7	1.9	2.16+.46
Pb	0.28	0.39	0.39	0.4+.06	0.18	0.29	0.29	0.3+.06

3.2. Removal Efficiency

The physicochemical, anionic, and cationic parameters like DO, EC, COD, BOD, TSS, TDS, Hardness, HCO_3-, PO_4^3-, SO_4^2-, Cl^-, N-NO_3-, Na, Ca, Cu, Cr, Zn, F, Pb, of treated effluent were not found within the permissible limits of (ISW-BDS-ECR and NEQS). The performance efficiency of CETP is presented in the following table (4,5,6,7). The efficiency of CETP was calculated by considering DO, EC, COD, BOD, TSS, TDS, Hardness, HCO_3-, PO_4^3-, SO_4^2-, Cl^-, N-NO_3-, Na, Ca, Cu, Cr, Zn, F, Pb, of the inlet and outlet of CETP. The percentage of reduction in TSS, BOD, and COD is 88%, 83.7%, and 79.5% respectively. The maximum reduction of 88 % was observed in TSS followed by BOD, COD, DO, Hardness, EC, and TDS which are 83.7 %, 79.5 %, 25 %,18 %, 2.4, and 4.8 % respectively. The above reduction indicates that removal efficiency ranges between 2.4 % to 88 % and average removal efficiency of 43 % (Table 4) which is quite low.

The percentage of reduction in N-NO_3-, PO_4^3-, HCO_3-, is 93 %, 74.5 %, and 73.8 % respectively.

The maximum reduction of 93 % was observed in N-NO_3-. The above reduction indicates that removal efficiency ranges between 2.6 % to 93 % and average removal efficiency of 55 % (Table 5). which is comparatively good. The percentage reduction of cationic parameters in Cr, Ca, Zn, Cu, Pd, Fe, and Na is 92%, 59%, 47%, 47%, 25%, 18.5%, and 3.7% respectively. A maximum reduction of 92 % was observed in Cr. The above reduction indicates that removal efficiency ranges between 3.7 % to 96 % and average removal efficiency of 42 % (Table 6). which is quite low. Then, finally, we found the overall removal efficiency of CETP is 47% (Table 7).

Table 4: Percentage removal of physicochemical parameters

Parameters (mg/L)	Influent (Avg)	Effluent (Avg)	% Removal	DoE-BD ,1997 standard	ISW-BDS-ECR	NEQS
pH	8.2	7.4	-	6-9	6-9	6-9
DO	.6	.8	25%	4-6	4.8-9	4-6
EC (μs/cm)	10996	10727	2.4%	1200	1200	288
TDS	6817	6486	4.8%	2100	2100	3500
TSS	1756	209	88%	150	-	150
BOD	553	90	83.7%	50	-	50
COD	1646	337	79.5%	200	-	200
Hardness	827	679	18%	-	-	
Overall efficiency (Physico-chemical parameters): (25%+2.4%+4.8%+88%+83.7%+79.5%+18%)/7= 43%						

Table 5: Percentage removal of Anionic Parameters

Parameters(mg/L)	Influent (Avg)	Effluent (Avg)	% Removal	DoE-BD,1997 standard	ISW-BDS-ECR	NEQS
HCO_3^-	1200	315	73.8%	_	_	_
PO_4^3-	28.3	7.23	74.5%	10	_	_
SO_4^{2-}	1900	1850	2.63%	400	_	5
Cl^-	2417	1667	31%	600	_	600
N-NO_3^-	60.18	4	93%	10	_	50
Overall efficiency (Anionic Parameters): (73.8%+74.5%+2.63%+31%+93%)/5=54.96%						

Table 6: Percentage removal of cationic parameters

Parameters(mg/L)	Influent (Avg)	Effluent (Avg)	% Removal	DoE-BD,1997	ISI-2000
Ca	218	89	59%	-	_
Cr	80.84	6.1	92%	.5	.1
Na	1884	1815	3.7%	_-	_-
Cu	1.7	.9	47%	.5	2
Zn	1.7	.9	47%	5	5
Fe	2.7	2.2	18.5%	2	_
Pb	.4	.3	25%	.01	.2
Overall efficiency (Cationic Parameters): (59%+92%+3.7%+47%+47%+18.5%+25%)/7=42%					

Table 7: Removal Efficiency of CETP

Parameters	Removal Efficiency (%)
Physico-chemical	43%
Anionic	55%
Cationic	42%
Overall	47%

4. Conclusion

The pollution due to the discharge of poorly treated tannery effluents in Bangladesh is of foremost environmental and public alarm. The study results showed high values of EC, TSS, TDS, TH, BOD_5, COD, NO_3^-, SO_4^{2-}, HCO_3^-, PO_4^{3-}, Cl^-, and metals (Na, Ca, Cr, Cu, Fe, Pb, and Zn) in the composite tannery influents and effluents collected from the tannery estate at Savar. The values of the physicochemical and anionic parameters were above the standard permissible limits of effluent discharge prescribed by the ISW-BDS-ECR (1997), DoE-BD (1997), and NEQS (2000). The mean concentrations of TSS, and TDS, were 1756, and 6817 mg/L, in the influent and 209, and 6486 mg/L, in the effluent, respectively. The pH value was 8.2 and 7.4 in the influent and effluent, respectively indicating a neutral to slightly alkaline range. The average values of DO, BOD, and COD were 0.6, 553, and 1646 mg/L in the influent and 8, 90, and 337 mg/L in the effluent, respectively, causing serious surface water pollution in the areas. The average EC was 10996 S/cm in the influent and 10727 S/cm in the effluent, and the concentrations of anions, including NO_3^-, SO_4^{2-}, HCO_3^-, PO_4^{3-} and Cl^-, were 60.18, 1900, 1200, 28.3, and 2417 mg/L in the influent and 4, 1850, 315, 7.2, and 1667 mg/L in the effluent, respectively. The values of metal ions in the composite tannery influents and effluents were in the following order: Na>Ca>Cr> Fe>Cu>Zn>Pb. The study summarized that the removal efficiency of CETP was 43% for physicochemical parameters, 55 % for anionic parameters, and 42 % for cationic parameters, and the overall efficiency of CETP was 47 %. Comparatively, the removal efficiency of CETP for anionic parameters was better than that for physicochemical and cationic parameters. But the overall removal efficiency of CETP was not satisfactory indicating improperly treated tannery effluent was not suitable for discharging into nearby surface water bodies. Such performances pose an intimidation factor for humans, aquatic life, and the environment. The study observed that the discharge composite influent should be properly treated before discharge into surrounding water bodies, and if the performance of the CETP was not satisfactory, it should be monitored regularly to achieve a sustainable environment. Further, the biological treatment process combined with the conventional treatment process could be adopted, and more research should be considered for developing an efficient treatment plant for a sustainable environment.

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