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ASSESSMENT OF PHYSICOCHEMICAL AND BIOCHEMICAL QUALITIES OF TANNERY EFFLUENTS OF HAZARIBAGH, DHAKA, AND COMPARISON WITH NON-TANNERY WATER SAMPLES

Laila N. Islam*, Adua Rahman, Zimam Mahmud, A. H. M. Nurun Nabi,
Mahmud Hossain and M. Mohasin
Department of Biochemistry and Molecular Biology, University of Dhaka,
Dhaka-1000, Bangladesh
*Corresponding author: lailanislam@yahoo.com

Abstract

In this study the physicochemical and biochemical qualities of the tannery effluents were analyzed to determine the pollution load of the openly released wastewaters in the environment and the findings were compared with the non-tannery waters. Fourteen samples of factory effluents were collected from the leather tanning industrial zone of Hazaribagh, Dhaka, and 13 non-tannery water samples were collected from different parts of Dhaka city. The effluents were mostly colored; their pH varied from highly acidic to basic values while densities were not much different from the non-tannery waters. The chromium contents of the effluents varied from less than 0.002 to 18.97 mg/L and the chemical oxygen demands (COD) varied from 90 to 6500 mg/L, which were significantly higher than those of non-tannery waters. There was a strong direct correlation between chromium content and COD ($p<0.01$) indicating that chromium was hugely responsible for pollution caused by tannery effluents. The tannery wastewaters were highly toxic to brine shrimp nauplii (lethality: about 82%), and chromium was responsible for biotoxicity of the effluents since a direct significant correlation ($p<0.021$) was found between chromium content and lethality. Storage of the wastewater samples for 2 to 8 months at room temperature showed rise in the pH values possibly due to microbial action that resulted in decrease of dissolved chromium content from a mean value of 7.94 to 5.09 mg/L. These findings demonstrated that the presence of high concentrations of chromium and other chemicals in the untreated tannery effluents were contributing adverse effects on the environment and ecosystem.
Key words: Tannery effluents, chromium, COD, brine shrimp biotoxicity, Hazaribagh, Bangladesh

Introduction

Bangladesh earns significant amount of foreign currency by exporting leather goods from its tanning industries. A recent report revealed that leather and leather products are one of the major external trade sectors which contribute up to 1.39% share on the total export earnings (EPB, 2009-2010). Hazaribagh, the largest tanning industrial area of the country situated on the south-western part of the capital city of Dhaka on the bank of the river Buriganga, has around 300 tanning units (Mohanta *et al.*, 2010). However, these industries are discharging and dumping their wastes and effluents without treatment into nearby water bodies. About 100,000 people are engaged with the leather industry directly and indirectly. In the peak season between 12,000 and 15,000 people work in the tanneries and during the off season their number decreases to between 8,000 and 12,000 (Biswas and Rahman, 2013).

The leather industry as a whole is under critical review by environmentalists throughout the world. In Bangladesh, the leather tanning industry has been identified as one of the main causes of environmental pollution in the capital city of over 15 million people (Cox, 2012). Hazaribagh is called a cancerous problem for Dhaka city (Huda, 2008). The workers of leather tanning industries suffer from double-edged problem: as an inhabitant, they face surrounding environmental problem directly, and as a worker of tanning industry, they suffer from detrimental chemicals and wastes which are generated in the tannery itself (Biswas and Rahman, 2013). The tannery workers are exposed to different corrosive chemicals during the processing of the raw hides to finished leather. They are also suffering from various physical health problems that are lowering their mental health condition (Muhammad and Haque, 2012).

The groundwaters as well as the ecosystem of the Hazaribagh area are on the verge of huge pollution. A study was conducted on the soil profile of Hazaribagh tannery area down to a depth of 5 meters and the surface accumulation of total chromium reaching as high as 28000 mg/kg have been encountered at 1 km distance from the waste lagoon (Shams *et al.*, 2009). The distribution of Cr (VI) has been irregular in the subsurface and a maximum of about 1 mg/kg have been measured at 3 m depth. Although soil pH is alkaline in general, a sharp drop of pH has been observed at some locations both in surface and subsurface layers to as low as pH 3.4. Such an acidic environment can play a significant role in the fate and mobility of heavy metals in nature (Shams *et al.*, 2009). Another study in the Southeast Asian region assessed the concentrations of total chromium in the soils and effluents of tanneries distributed in ten clusters of Sialkot District, Pakistan, and found (Cr) to be in range of 3.45-11.43 mg/kg, and 16.12-36.83 mg/L, respectively (Rafique *et al.*, 2010).

The hexavalent chromium detected in alkaline environment in subsurface can enhance its mobility both vertically down to the aquifer and laterally towards the river Buriganga, hence again to the aquifer as the river and the aquifer are hydraulically connected (Shams *et al.*, 2009). The effects of effluents from tanning industry and its toxicity on survival and histopathological changes of snakehead, *Channa punctatus* were studied. It was found that the effluents were so toxic that fishes couldn't survive in it even for two hours and histopathological changes in liver, kidney, intestine and stomach were observed (Mohanta *et al.*, 2010). Chromium inhibited growth of duckweed and algae, reduced fecundity and survival of benthic invertebrates, and reduced growth of freshwater fingerlings (Vera-Candioti *et al.*, 2011). Another study reported that the raw wastewater effluents of the

Hazaribagh tanneries exhibited high acute toxicity to the bacterium *Vibrio fischeri*, the higher plant *Lactuca sativa*, and the microcrustacean *Daphnia magna*, suggesting that the raw wastewater effluent had detrimental effects on broad spectrum of organisms in the aquatic ecosystem (Arias-Barreiro *et al.*, 2010). Chemical analysis revealed that the raw effluent sample contained an extremely high concentration of chromium (47 g/L).

Due to threatening effects of chromium containing wastewater, treatment of the tannery effluents is a matter of great concern in the country. A number of researches have been carried out around the world regarding treatment of tannery effluents using different technology. For example, adsorption of hexavalent chromium from tannery effluents using formaldehyde treated sawdust and charcoal of sugarcane bagasse (Dhungana and Yadav, 2009), treatment of tannery wastewater using filtration, ultra-filtration and reverse osmosis process with a view to reuse it again (Krishnamoorthi *et al.*, 2009). Several studies have been carried out for the treatment of industrial effluents through coagulation and flocculation processes (Shouli *et al.*, 1992; Stephenson and Duff, 1996). A few studies focused on bio-remediation of tannery effluents (Sepehr *et al.*, 2005; Haydar *et al.*, 2007). In view of shortage of data on the current situation, this study was undertaken to assess the physicochemical and biochemical qualities of the tannery wastewaters of Hazaribagh, Dhaka, and compare the findings with non-tannery waters.

Materials and Methods

Collection of the water samples

To perform the study on tannery wastewater, 14 samples were collected of which 12 were from the main drainage outlet or adjacent drain of different leather tanning industries of Hazaribagh, and 2 were from the main sewage drains connected to the nearby river Buriganga. About 500 mL of tannery effluents were collected in clean plastic containers. Figures 1 and 2 are showing the sites of collection of the tannery wastewater samples (TWW1-TWW14) and locations of the tanneries from where raw effluents were collected, respectively. As controls, non-tannery water samples (NTW1-NTW13) were collected from different drains of Dhaka University area, ponds, river Buriganga (downstream from source), household, water supply, commercial bottled water and distilled water. Table 1 shows the sites and locations of water sample collection.

Figure 1: Sites and locations of collection of tannery wastewater samples. The figure shows heavily polluted water of the river Buriganga due to dumping of industrial wastes and effluents.

Determination of chromium content

The water samples were analyzed for the measurement of chromium using a Varian 240 Atomic Absorption Spectrophotometer (240 AAS). The procedure uses acetylene flame (combustion with air, temperature: 2500^0C) to vaporize the samples. The Varian 240 AAS analyzer utilizes a hollow cathode lamp which is specific for chromium detection in gaseous state then detects the total chromium content in the samples.

Determination of pH

The water samples were filtered before pH determination using Whatman No.1 filter papers. The pH of the water samples was measured using a bench top Hanna (USA) pH meter. It uses a glass body electrode to detect pH of the sample solutions with accuracy of ± 0.01 pH.

Determination of density

The water samples were filtered before density analyses. The densities of water samples were determined by measuring 10 mL of water samples using a Scientech digital analytical balance. The results were finally expressed in g/L.

Determination of chemical oxygen demand

The tannery effluents and non-tannery water samples were directly used without filtration for the determination of chemical oxygen demand (COD). The organic matters present in the sample were oxidized completely by potassium dichromate in the presence sulfuric acid, silver sulfate and mercuric sulfate to produce CO_2 and H_2O. Excess potassium dichromate was determined by titration against ferrous ammonium sulfate using Ferroin as an indicator. The dichromate consumed by the sample was equivalent to the amount of O_2 required to oxidize the organic matter.

Figure 2: Locations of tanneries (yellow colored) in Hazaribagh, from where effluent samples were collected.

Brine shrimp lethality assay

Brine shrimp eggs were obtained from the local market. Artificial seawater was prepared by dissolving sea salt in distilled water and was filtered for use in hatching the shrimp eggs. The seawater was taken in an aerated hatching chamber and shrimp eggs were added into the dark side of the chamber while the lamp above the other side would attract the hatched shrimp. Two days were allowed for the shrimp to hatch and mature as nauplii (larvae). Sea salts were added to the test water samples to prepare the artificial seawater concentration. The following dilutions of test water samples were made using artificial seawater: 1:0, 1:1, 1:4, and 1:9. When the shrimp larvae were ready for biotoxicity/lethality assay, 5 mL of each dilution of prepared water samples were taken in 3 test tubes and 10 brine shrimps were introduced into each tube. Thus, there were a total of 30 shrimps per dilution. The test tubes were left uncovered under the lamp. The number of surviving shrimps were counted and recorded after 24 hours. Using probit analysis, the Po (observed mortality) and Pc (control mortality) were determined, and Pt (corrected mortality) was calculated by the formula, $Pt=[(Po-Pc)/(100-Pc)]\times100$. The corrected mortality was calculated by dividing the actual number of dead nauplii by the total number, and then multiplied by 100. This was done to ensure that the lethality (mortality) of the nauplii was attributed to the toxic chemicals present in the tannery wastewaters.

Statistical analyses

Data analyses were carried out using the Statistical Package for Social Sciences (version 17.0 for Windows, SPSS Inc., Chicago, USA). The programs used were Independent sample t-test for comparison of tannery wastewater and non-tannery water samples, Pearson correlations, and Descriptive statistics. The results were considered significant when p was ≤ 0.05.

Table 1: The sites of collection and appearance of the tannery wastewater and non-tannery water samples

Entry No.	Sites of collection of tannery wastewater and color of the samples	Entry No.	Sites of collection of non-tannery water and color of the samples
TWW1	*SLC* northern drain, copper color	NTW1	Physics Dept. drain, colorless
TWW2	*Dhaka Hide and Skin* drain, colorless	NTW2	Shahidullah Hall pond, colorless
TWW3	Buriganga-Hazaribagh intersection, colorless	NTW3	Zoology Dept. drain, colorless
TWW4	Buriganga Sluice Gate, brownish	NTW4	BMB Dept. drain, colorless
TWW5	*Apex Tannery* western drain, yellowish	NTW5	Jagannath Hall pond, light green
TWW6	*Ayub Brothers* drain, grayish brown	NTW6	DUCSU Office drain, colorless
TWW7	*FK Leather* drain, colorless	NTW7	BMB Dept. Tap water, colorless
TWW8	*Rana Leather* drain, black	NTW8	Buriganga, opposite to Hazaribagh, cl
TWW9	*SLC* southern drain, aqua blue	NTW9	Buriganga River, middle point, cl
TWW10	*Mukta & Emon Leather* drain, orange brown	NTW10	Household water of DU area, cl
TWW11	*Apex Tannery* eastern drain, copper color	NTW11	Mineral water, MUM, colorless
TWW12	*Delta Tannery* drain, yellowish	NTW12	Supply water of Hazaribagh, cl
TWW13	*SLC* western drain, yellowish	NWT13	Distilled water from SWE Dept., cl
TWW14	*Ruma Leather* drain, black		

SLC: Shafiq Leather Corporation; BMB: Biochemistry and Molecular Biology; SWE: Soil, Water and Environment; DUCSU: Dhaka University Central Student's Union, cl: colorless

Results

Color of tannery effluents and non-tannery water samples

Most of the tannery wastewater samples (TWW1–TWW14) had different colors when they were collected. The non-tannery water samples (NTW1–NTW13) were mostly colorless. The different color in the wastewater samples indicated the presence of various chemicals and organic matters in the tannery effluents. The color of the water samples was determined from the Wikipedia List of Colors and the observations are presented in Table 1.

pH of the study water samples

Of the 14 tannery wastewater samples, 2 had very low pH values showing highly acidic nature (pH < 7.0) and the remaining 12 samples were basic in nature (pH > 7.0). The pH of the tannery wastewaters varied from 3.93 to 8.51, and the median value was 8.08. Of the 13 non-tannery water samples, 12 were basic in nature (pH > 7.0) and the remaining one had acidic pH (< 7.0). The pH of the non-tannery water samples varied from 6.7 to 8.39 and the median value was 7.8. Statistical analysis showed there was no significant difference (p = 0.435) in pH values between the tannery effluents and non-tannery waters. The results are presented in Table 2.

Table 2: Comparison of physicochemical parameters of the tannery wastewater and non-tannery water samples

Study samples	pH Mean ± SD	Chromium (mg/L) Mean ± SD	Density (g/L) Mean ± SD	COD (mg/L) Mean ± SD
Tannery waste water N=14	7.53 ± 1.4	4.90 ± 6.44	998.79 ± 26.37	1655.7±2072.9
Non-tannery water N=13	7.85 ± 0.44	0.006 ± 0.015	971.69 ± 52.84	45.0 ± 37.41
Statistics	*p = 0.435*	*p = 0.014*	*p = 0.1*	*p = 0.012*

Levels of chromium in the study water samples

Out of the 14 tannery wastewater samples, only 1 had chromium level below the detection limit (< 0.002 mg/L), the remaining 13 samples had chromium levels ranging from 0.025 to 18.97 mg/L, and the median value was 2.16 mg/L. Of the 13 non-tannery water samples, 11 had chromium content below detection limit and the remaining 2 had chromium levels 0.008 and 0.056 mg/L while the median value was < 0.002 mg/L. Statistical analysis showed significantly higher chromium content in the tannery wastewaters (p = 0.014, Table 2).

Density measurement of the water samples

The weight per unit volume of the water samples was determined in an electric balance. The total 14 tannery effluents had density ranging from 959 to 1037 g/L with the median value of 1001.5 g/L. The total 13 non-tannery water samples had density ranging from 915 to 1023 g/L and the median value was 986 g/L. Statistical analysis showed no significant difference (p = 0.1) in densities between the tannery wastewater samples and non-tannery water samples (Table 2).

Levels of chemical oxygen demand in the water samples

It was found that the COD of the tannery effluents varied widely from 90 to 6500 mg/L and the median value was 775 mg/L. On the other hand, the COD of the non-tannery water samples varied from 10 to 150 mg/L and the median value was 40 mg/L. Statistical analysis showed that the tannery wastewaters had significantly higher ($p = 0.012$) COD value than that of the non-tannery water samples. The results are presented in Table 2.

Effects of the tannery effluents on brine shrimp

The toxic effects of the tannery effluents on brine shrimp nauplii lethality varied from 33.3 to 100%. It was found that 5 of the 14 effluent samples (undiluted) caused 100% lethality of the brine shrimp larvae. The tannery waste water sample TWW8 caused 100% lethality even at 1 in 10 dilution. The mean ± SD biotoxicity value of the tannery effluents was 81.7 ± 20.9 with a median of 88.9 %. The biotoxicity data are presented in Figure 3.

Effect of storage on pH and chromium content of the tannery effluents

Storage of 6 randomly selected tannery wastewater samples showed marked increase in pH values. It was found that the mean pH value of these wastewater samples was 6.73 ± 1.93 at the beginning (first reading) that increased to 7.50 ± 1.56 at the second reading after storage for 60 – 240 days. Table 3 is showing the change in pH values of the tannery wastewater samples. Concurrently, there was marked decrease in the dissolved chromium content in these wastewater samples that were stored at room temperature. It was found that while the mean chromium content of these water samples was 7.94 ± 5.59 mg/L at the first reading the value decreased to 5.09 ± 3.61 mg/L at the second reading after storage for 60 – 240 days. The loss of dissolved chromium was due to precipitation. Table 3 is showing the results.

Table 3: Effect of storage on the pH and chromium contents of tannery wastewaters

Tannery waste water samples	pH values		Chromium content (mg/L)		Storage time between readings (days)
	1st reading	2nd reading	1st reading	2nd reading	
TWW1	7.63	8.35	6.00	3.91	60
TWW2	4.69	7.69	3.03	1.99	60
TWW6	7.40	8.34	6.65	5.20	240
TWW8	3.93	3.94	18.53	11.97	240
TWW10	8.21	8.37	4.31	2.46	240
TWW14	8.51	8.32	9.09	4.99	240
Mean values	*6.73*	*7.50*	*7.94*	*5.09*	*180*

Correlation of chromium content with COD

The correlation analysis showed there was a strong, highly significant ($p < 0.01$, $r^2=0.948$) direct relationship between chromium content and the level of chemical oxygen demand in the tannery wastewater samples (Figure 4). No such correlation was found between COD and chromium content of the non-tannery water samples, most of which contained chromium content below detection limit (< 0.002 mg/L). These findings indicated that chromium was directly responsible for pollution caused by tannery effluents.

Correlation of chromium content with brine shrimp lethality

It was found that there was a significant direct relationship (p = 0.021, r = 0.59) between chromium content and the level of toxicity exerted by the tannery wastewater samples on brine shrimp nauplii. These results of high concentrations of chromium exhibiting extreme biotoxicity on brine shrimps suggested lethal effects of the untreated tannery effluents on the ecosystem.

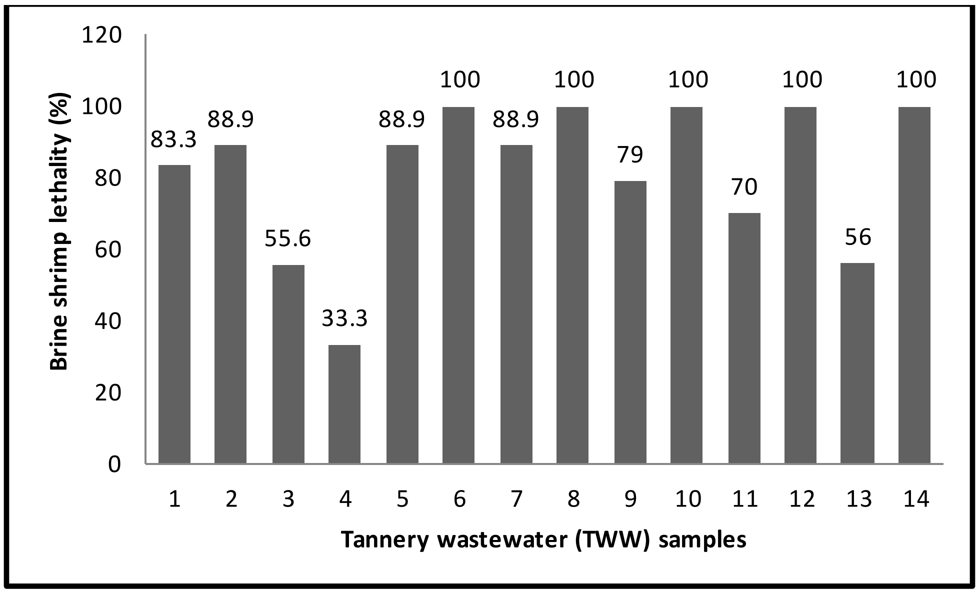

Figure 3: Effect of tannery wastewater (TWW1-TWW14) samples on brine shrimp lethality. Undiluted TWW samples 6, 8, 10, 12 and 14 caused 100% lethality of the brine shrimp larvae.

Discussion

The tanneries of Hazaribagh are causing serious health problems to the residents of Dhaka city as they are situated in a densely populated area. Most of the tanneries in this leather tanning industrial zone are 30–35 years old and use mineral tanning processes. According to a report of the World Health Organization released by the Bangladesh Society for Environment and Human Development (SEHD, 2001), a large numbers of the 8000-12000 workers at the tanneries suffer from gastrointestinal, dermatological and other diseases that could be related to the pollution at their workplace and that 90% of them die before the age of 50 years compared to less than 60% for the country as a whole. Chromium is one of the most harmful chemicals found in the tannery waste because of its carcinogenic potential. Acidic effluents can cause severe respiratory problems, while gaseous emissions from the tanneries contain sulfur dioxide that is converted into sulfuric acid on contact with moisture and can damage lungs (SEHD, 2001).

According to a report titled, “The Top Ten Toxic Threats: Cleanup, Progress, and Ongoing Challenges” published by Zurich-based Green Cross Switzerland and New Yorkbased Blacksmith Institute, at least 160,000 people of Dhaka city have become victims of pollution due to the presence of toxic chemicals, mainly chromium, in Hazaribagh. According to the Bangladesh Government, from the tanning units of Hazaribagh area, every day roughly 21000 m^3 of untreated wastewaters containing various chemicals go to the low-lying areas and to the nearest water bodies including the river Buriganga which is a major water source for agricultural purposes as well as for fishing activities for the local population (Ludvik, 2000). In Bangladesh, it has been well documented that wastewater discharged from tanneries without appropriate treatment results in detrimental effects on the ecosystem. However, ecotoxicity evaluation of the aquatic environment in Bangladesh has been mostly overlooked.

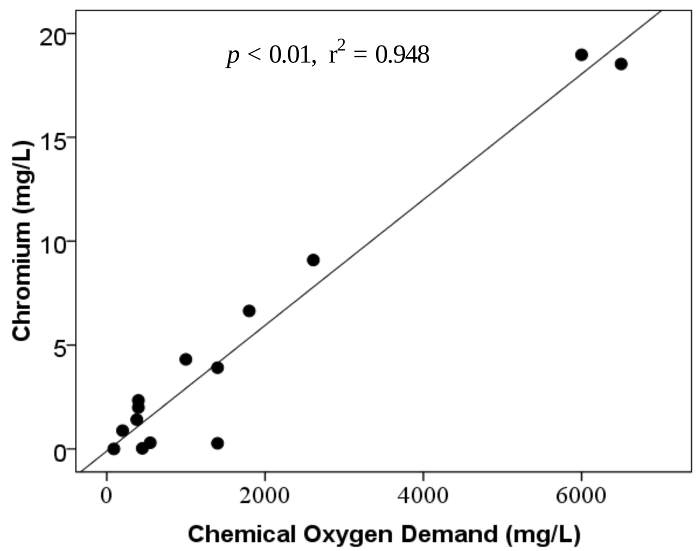

Figure 4: Strong, highly significant direct correlation between the chromium content and COD of the tannery wastewaters ($p < 0.01$, $r^2 = 0.948$).

It has been reported that the extremely colored tannery wastewater is acidic in nature with high chromium content including other pollution loads causing high chemical oxygen demand, biochemical oxygen demand, dissolved salts etc. (Sreeram and Ramasami, 2003). The discharge of the effluent without treatment is creating great environmental threats. The physical and chemical characteristics of the tannery effluent before treatment were determined in one study and the raw effluent was found to contain chromium in extremely high concentration (987 mg/L); COD, total suspended solid, total dissolved solid and conductivity of the effluent were also high for the presence of various chemicals used for leather processing as well as for the dissolved protein (e.g. collagen) from the leather (Sabur *et al.*, 2012). Presence of different toxic chemicals including chromium rendered the tannery effluents unsuitable for the survival of fishes, other aquatic animals, plants and algae (Mohanta *et al.*, 2010; Vera-Candioti *et al.*, 2011).

Haphazard disposal of untreated waste from households as well as institutions and industry is causing severe deterioration of water bodies in many urban areas in the developing world. Most cities do not have adequate systems for the collection and treatment of wastewater and this is usually not considered to be a priority for investment (Dahal, 2014).

The heavy metal pollution level of tannery effluent-affected lagoon and canal waters of Hazaribagh had been analyzed in one study that found the mean concentrations (in mg/L) of Cr (5.27), Pb (0.81), As (0.59), and Cd (0.13) in the water samples were very high (Bhuiyan *et al.*, 2011). These findings evidenced that effluents discharged from the tannery and auxiliary industries and urban sewage system were the main sources of heavy metal pollution in the lagoon and canal water systems that would have serious public health and potential environmental hazard implications.

In the present study, most of the tannery wastewaters were found to have different colors. Their mean pH values were lower than that of the non-tannery water samples. The densities of the tannery waste waters were higher indicating the presence of dissolved solids compared to the non-tannery waters. Their chromium content and COD values were significantly higher than non-tannery water samples. Correlation analyses showed high content of chromium in the tannery effluents was responsible for pollution (high COD) and lethality of brine shrimp larvae. Previous workers also found that the raw wastewater effluents of the Hazaribagh tanneries containing extremely high concentration of chromium (47 g/L) exhibited high acute toxicity to the bacterium *Vibrio fischeri*, a higher plant and microcrustacea, suggesting detrimental effects of Cr on the aquatic ecosystem (Arias-Barreiro *et al.*, 2010).

Storage of some tannery waste water samples at the room temperature without acid treatment showed marked increase in pH and decrease in soluble chromium content due to sedimentation. The increase in pH might occur due to the action of microorganisms on dissolved proteins in tannery wastewater samples that in turn caused chromium precipitation, suggesting a natural remediation process to remove soluble chromium. One study reported accumulation of chromium reaching as high as 28000 mg/kg in the soils of Hazaribagh at 5 meter depth as far as 1 km distance from the waste lagoon (Shams *et al.*, 2009). The concentration of total chromium in the soils of tanneries in Sialkot District, Pakistan was found 3.45-11.43 mg/kg (Rafique *et al.*, 2010), which was much lower than that of Hazaribagh.

There are strict regulations in many countries regarding the maximum COD allowed in wastewater before they can be returned to the environment. The government of Bangladesh has set the characteristics of effluent at discharge point for industrial units and projects (GAETP, 2008) but due to lack of awareness and monitoring, the tanneries openly release raw wastewaters to the environment and pollute the low-lying areas, canals, and the nearby river Buriganga. Due to the presence of many chemicals the amount of dissolved oxygen is very low in the wastewaters. Aquatic animals such as fish depend on higher level of dissolved oxygen for respiration. The amount of dissolved oxygen in water is dependent on the quantity of sediment in the stream, the amount of oxygen taken out of the system by respiring and decaying organisms, and the amount of oxygen put back into the system by photosynthesizing plants, stream flow, and aeration. These vital qualities were absent in the wastewaters of Hazaribagh tanneries.

In contrast to a previous study that reported the chromium level to be 987 mg/L in a raw effluent sample (Sabur *et al.*, 2012), the present study found the highest level of chromium in one effluent sample to be around 19 mg/L while the mean value of 14 samples was 4.9 mg/L. This variation could be due to the fact that the previous researchers collected samples from the chromium operational condition of the tannery whereas our effluent samples were collected mostly from the main drainage outlets (Table 1), which could be mixed with used waters of other units of the leather tanning factories. It had been reported earlier that the minimum conductivity of the lime treated effluent had the lowest ionic mobility resulting in coprecipitation of chromium in the form of $Cr(OH)_3$ (Sabur *et al.*, 2012). Our observations support the findings of the previous investigators in that through utilization of organic matters (mainly proteins) the microorganisms help increase the pH of the effluent waters which in turn cause desolubilization of the chromium (by sedimentation) from the tannery wastewaters. Sedimentation could be the reason for very high chromium content in the soils of Hazaribagh.

In this study, water samples from two ponds (NTW2 and NTW5) were included among the non-tannery waters that gave COD values 20 and 50 respectively; both had pH values around 7.7, and allowed over 85% of brine shrimp larvae survival, suggesting environment-friendly water qualities. The pH of the Buriganga river waters (NTW8 and NTW9) from two points (downstream, away from source) were found 8.24 and 8.23, chromium contents in both were <0.002 mg/L. It is possible that the untreated effluents and solid wastes from the tanneries of Hazaribagh disposed to the open stream are degraded by bacterial action into smaller components while oxygen is required both for the survival of these bacteria and for the breakdown of the component that create high oxygen demand causing death to the dependent plants, bacteria, green alga, crustaceous and fishes, as observed by previous workers (Mohanta *et al.*, 2010; Arias-Barreiro *et al.*, 2010). The openly discharged effluent heavily contaminated with chromium remains in the ecosystem for long-terms and it is accumulative. The neutral salts of heavy metals, oil and grease and other chemicals present in the effluents might have different toxicity even at low concentrations. These could be the reasons that 5 out of 14 tannery effluent samples assessed in the present study caused 100% lethality to brine shrimp larvae while another 5 samples caused 80-90% lethality. Also the COD values of these samples were very high.

Conclusion

Considering our findings on the physicochemical and biochemical qualities, it may be concluded that the untreated effluents of the tanneries of Hazaribagh, Dhaka, are directly causing serious threats to the environment and ecosystem. There should be rigorous management strategies in order to maintain, conserve and to avert the ecological imbalance and disturbance in hydro-geochemical and hydro-biological cycles, which adversely affect the food chain and food web of the significant water body ecosystem. Therefore, the raw effluents of the tanneries must be subjected to treatment before being discharged openly.

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