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Investigation on Physicochemical Parameters of Tannery Effluent

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Abstract:

This study was accomplished to find out the qualities of tannery effluents with the assessment of Physicochemical parameters of effluents liberated by the tanneries in Dhaka, Bangladesh. Effluents were gathered from nine tanneries and three ejected points of area Hazaribagh, Dhaka. Various physical and chemical properties like Alkalinity, Biological Oxygen Demand , Chemical Oxygen Demand , Chloride, Color , Dissolved Oxygen , Electrical Conductivity , Nitrate, Odor, Phosphorous, , Sulphate, , Suspended Solid, Temperature, The pH, total Dissolved Solids etc. were evaluated and matched up to standard levels .The observed ranges of the values are 1072-3833 mg/L for TSS, 1251-6240 mg/L for COD, 3.2-10.43 for pH, 2375-4385 mg/L for TDS, 200-1257 mg/L for BOD_5, 7.81-13.85 mg/L for phosphorous, 2100-9745.8 µs/cm for EC, 684-1020.2 mg/L for alkalinity, 2.85-22.34 mg/L Cr^{3+}, 8-26 mg/L for NO_3^- ,484-1928 mg/L for Cl^-, 0.68-2.8 mg/L for NO_2^- and 124-512 mg/L for SO_4^{2-}.

Keywords: Alkalinity, Biological Oxygen Demand, Chemical Oxygen Demand, Dissolved Oxygen, Electrical Conductivity, Suspended Solid, Tannery Effluent, Total Dissolved Solid.

1.0 Introduction:

Tannery, oldest industries in Bangladesh is mostly situated at the south western area of Dhaka city named Hazaribagh. There are 185 tanneries are situated in this area (Zannatul et al., 2012). This area and also the whole capital are being mainly contaminated with the untreated effluent ejected by the tanneries. Specially, the water of the river Buriganga which is beside the area is being polluted adversely. Recently the area has been included at the list of top 10 most polluted places of the earth (Blacksmith Institute Switzerland, 2013).

The tanneries of Hazaribagh are liberating fat, and skin, poisonous chemicals, lime, alkali, acids, bleach, dyes, oils, hydrogen sulfide, heavy metals, etc. which are generally merged to the river of Buriganga without any action (Chowdhuri et al., 2013). Nowadays chrome tanning is favored most for the benefit of the rapidity of processing, little cost and better permanence of the produced leather (Mant et al., 2005). The Elevated quantity of Chloride creates more salinity in water (Murali et al., 2013). Leather adopts merely 60-80 percent of total Chromium in the chrome tanning process, the rest creates severe ecological effects when merged in the environment according to Murali et al.,(2013). The tanneries of Hazaribagh dump huge industrial wastes which are not treated simply by usual way (Swarthi et al., 2014). 15800m^3/day of dissipated water with a BOD of 17600 kg/day and high chromium concentration is ejected from the tanneries at Hazaribagh by Bissas and Hamada (2012).

Tannery wastewater encloses extensive amounts of perilous pollutants in which heavy metals are very common (Saranraj and Sujitha, 2013). According to Krishnamoorthi and Saravanan (2011), the heavy metals can create cancer, brain or kidney damage. One of the greatest environmental problems in the tanneries is the

removal of chromium contents matters created as a byproduct. Tannery effluents mostly influence the ecosystem of the rivers and declines seeds germination in cultivable crops (Koizhaiganova et al., 2014). Tannery wastewater is an key resource of chromium to the nature by Asfew et al., (2011). The environment of Hazaribagh and the adjacent areas of it are extremely disgraced by the toxic elements generated by the tanneries (Zouboulis et al.,). According to Jolly et al., (2012), Buriganga, situated in this area is the most polluted among all the rivers in Bangladesh. The aim of this analysis is to assess the properties of effluent of the tanneries situated at the Hazaribagh area as well as the impacts for these on the whole environment of the area.

2.0 Materials and Methods:

2.1 Effluent Collection:

In our study, effluents were collected from nine tanneries and three final discharged points of Hazaribagh and other areas near it. Table 1 shows the name of the tanneries and the points with the identification number.

Table 1: Name of the tanneries of effluent collection and the identification no. of samples

Collected sample ID	Name of the Tannery of Points
1	Apex Tannery Ltd
2	F.K Leather Complex Ltd
3	Bangla Tannery
4	R M M Leather Industry Ltd.
5	H B Tannery Ltd.
6	Fancy Leather Ltd.
7	BeriBadh point -1
8	Rayerbazar point -2
9	Hazaribagh Bazar Point-3
10	Ruma tannery
11	Chowdhury tannery
12	Madina tanner

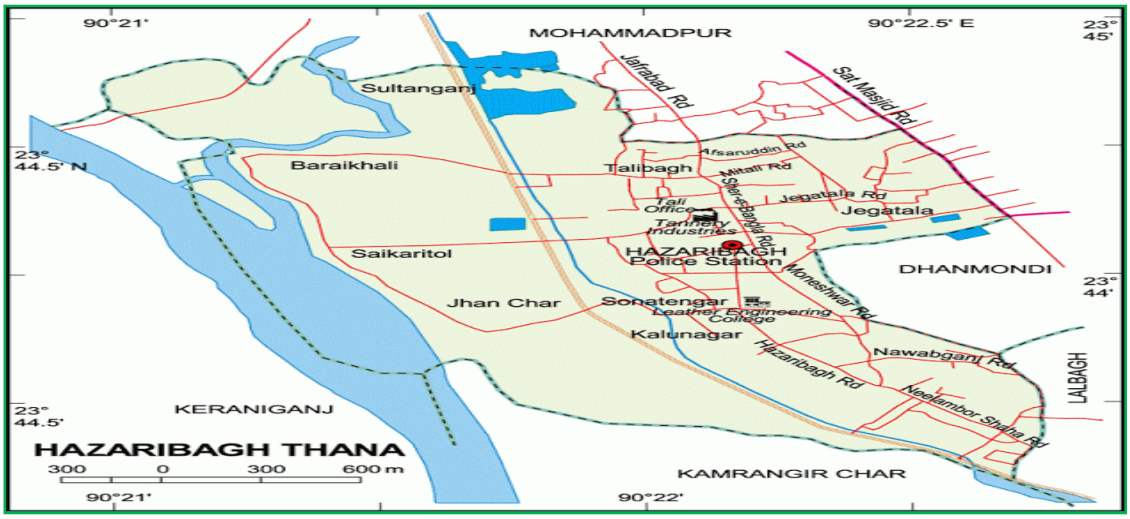

Figure 1 : Location map of Hazaribagh Dhaka , the studied area

Most of the samples were analyzed at the analytical chemistry Lab (ISO 17025 accredited) situated at the Institute of Leather Engineering and Technology, University Of Dhaka. Again, some tests were done at The Center for Advanced Research and Sciences, University Of Dhaka and Bangladesh Council of Scientific and Industrial Research, Dhaka.

2.2 Methods/ Instruments of the Parameters:

Table 2 shows the process or instruments for the analysis of the effluents of different tanneries along with showing the abbreviation of the name of the parameters.

Table 2: Methods or Instruments Used for the Determination of the Parameters of Effluents

Sl No.	Name of The Parameters	Abbreviation	Method of Analysis/Instruments
1	pH	-	pH meter
2	Electrical Conductivity	EC	Digital conductivity meter
3	Total Dissolved Solid	TDS	Gravimetric Method
4	Dissolved Oxygen	DO	Titrimetric Method
5	Chemical Oxygen Demand	COD	Titrimetric Method
6	Biological Oxygen Demand	BOD_5	Microbiological titration method
7	Suspended Solid	SS	Gravimetric Method
8	Chloride	Cl^-	Colorimetric method
9	Nitrite	NO_2^-	Colorimetric Method
10	Sulphate	SO_4^{--}	UV- visible Spectrophotometer
11	Phoisphorous	PO_4^{---}	Molybdo-vanadophoshphoric acid method
12	Alkalinity	-	Titrimetric Method
13	Color and Odor	-	Visual Observation
14	Temperature	-	Thermometer
15	Chromium	Cr^{3+}	Colorimetric method
16	Nitrate	NO_3^-	Colorimetric method

3.0 Results and Discussion:

3.1 Determination of Physical Parameters of Tannery Effluent:

Table 3 represents the physical analysis like as temperature, color and odor of the effluent collected from the tanneries of the area of Hazaribagh, Bangladesh. The above table shows different physical characteristics like the temperature, color and odor of samples. The observed temperature of the samples was less than the standard temperature. For tannery effluent in Bangladesh, 40^0 C is considered the standard temperature for tannery effluent in Bangladesh.

3.2 Chemical Determination of the Tannery Effluent:

3.*2.1 pH and Total Dissolved Solid (TDS):*

The study concludes the average value of pH of the effluent sample as 6.56. Here the highest value of pH 10.43 was found for sample-12 and lowest 3.2 for sample-7(Fig. 1) . Most of the samples were either high acidic or high basic. Almost all the observed values were deviated from the standard pH value 6-9, according to the directions of the Department of Environment (DoE), Bangladesh for industrial wastes. This may form a negative impact on the existence of aquatic lives. Most metals get soluble in water at low pH (Mozammel et al., 2015). By the TDS value the evaluation of entire combination of minerals and salts can be known by Nivrati et al., (2013). In this research, the TDS values of the tannery effluents were higher than the standard one (2100 mg/L). The highest value of TDS was found as 4385 mg/L for sample 4 and lowest 2375 mg/L for sample 8 (Fig. 2). High amount of dissolved solid elements obstructs the density of water. Thus, it generates impact on osmoregulation of water and also lessens solubility of gasses according to Azike et al., (2011).

3.2.2 Chemical Oxygen Demand (COD) and Total Suspended Solid (TSS):

For knowing the excellence of water quality, both COD and BOD_5 were crucial factors (Ram et al., 2011). The study reveals that COD levels of tannery effluent are severely higher than the standard level. The average COD value of observation was 2776.83mg/L. Here, the highest value of COD was found for sample- 5 and the lowest value was found for sample- 12 (Fig. 3). High COD can be for the large amount of inorganic compounds which are not generally influenced by the bacterial corrosion (Joseph et al., 2010). The results expressed the higher level of TSS of the effluent shown in the Fig. 4. It exceeded the allowed TSS level of 150-500 mg/L. High level of total suspended solid in water results poor photosynthetic system in the aquatic process and hampers respiratory method of fishes a lot (Mohamed et al. 2011).

3.2.3 Biological Oxygen Demand (BOD_5) And Electrical Conductivity (EC):

The experimental average BOD_5 value was 754.15 mg/L which is extremely higher than the tolerable limit. The Lower BOD_5 value represents lower contagion in water(Avit Kumar Bhowmic, 2008). The sample-5, showed the highest BOD_5 value of 1257 mg/L and sample- 1 of 200 mg/L as lowest (Fig. 5). The experimented average EC value was 5610.46 µs/cm for the observed tannery effluents was significantly higher than the standard value of 1200 µs/cm. The highest EC value of the samples 9745.8 µs/cm was found for the sample-11 and lowest 2100 µs/cm for sample- 1 (shown in Fig. 6) which was very large in amount. Augment in EC values shows elevated concentration of ions according to Deepali et al.,(2009).

3.2.4 Alkalinity and Phosphorus:

This investigation reveals the alkalinity among the effluent samples 1420.2 mg/L as highest and 684 mg/L as lowest(Fig.7). The average value of alkalinity of the experiment was 1018.08 mg/L which was higher according to the DoE standards. The reasons of huge portion of it is containing hydroxides, carbonates and bicarbonates (Islam et al., 2014). The experimental average phosphorus value was 10.35 mg/L. The highest observed value of it was 13.78 mg/L for sample-12 and 7.81 mg/L for sample-5 as lowest (Fig. 8). The observed results were larger than the standard value.

3.2.5 Sulfate (SO_4^{--}) and Dissolved Oxygen (DO):

The average sulfate rate of the tannery effluent was found as 300.75 mg/L. The highest value of sulfate was found 412 mg/L for sample- 5 and 158 mg/L for sample-1 as lowest (Fig. 12). The expulsion of combined tannery with household wastewater into the river depletes the dissolved oxygen present and hinders the aquatic creatures adversely by Rajagopala and Knmant, (2008). According to the UNIDO (2011), Sulfates in tannery effluent are originated from the utilization of sulfuric acid or formation with a high sodium sulfate content. DO was found in a very low amount for the collected effluent. For the samples of 4, 7 and 8 DO was found nil. The highest amount was found as 3.8 mg/L for sample -1.

3.2.6 Chromium (Cr^{3+}) and Nitrite (NO_2^-):

The chrome tanning process originates toxic metals and regular treatment systems are not eligible for the elimination of it (Saritha and Meikandaan, 2013). Chromium infectivity gets significance for its severe lethal behavior at a lessen concentration (Abinaya et al., 2015). Cr(VI) is a widespread noxious waste can be formed easily by the tannery effluents which are not processed. The toxicity of Cr(VI) is 500 times higher than Cr(III) (Kushwaha and Kanjan, 2015). It is carcinogenic and restrain enzymes and nucleic acid production of biological process by Anndbabu and Yogamoorthi, (2014). This observation expressed the average chromium value of 1.95 mg/L which was significantly higher than the standard (0.5-10) mg/L range. Again, the sample-7 expressed the highest amount of 2.79 mg/L and sample-1 for 0.68 mg/L as lowest (Fig. 10). The average experimental amount was 1.47 mg/L. Nitrite was found higher also shown in the Fig. 11

3.2.7 Chloride (Cl^-) and Nitrate (NO_3^-):

The average value of chloride was 1333.67 mg/L and the highest Chloride value 1928 mg/L for sample-5 and the lowest 484 mg/L for sample-12 (Fig. 9). According to Rouf et al.,(2013), the increased amount of chloride enhances the acridity of water. Nitrate was recorded 26 mg/L for sample- 5 and 8 mg/L for sample- 6. The average nitrate value of the observation is 15.83 mg/L (Fig. 13). The amount of the nitrate was upper than the standard 10 mg/L. The major trouble of Nitrogen compounds released to the environment is burning up dissolved oxygen in water (Alavi et al, 2013).

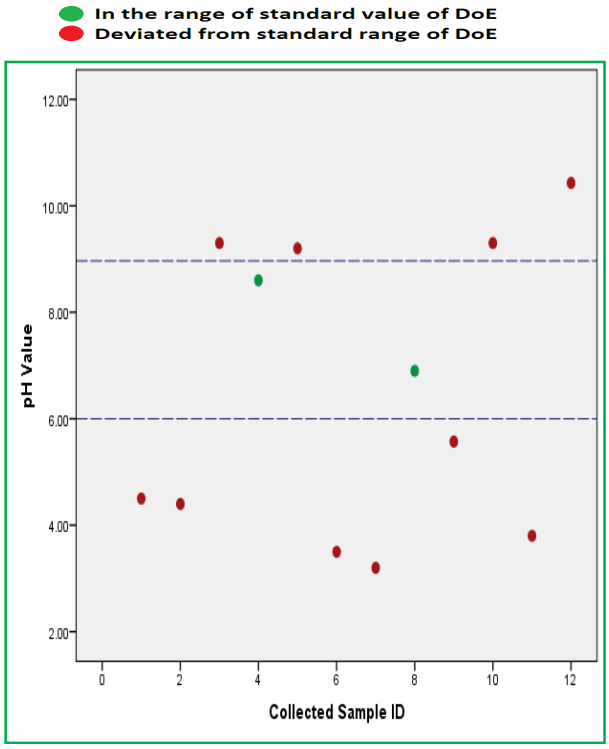

Figure 1- pH of the samples with DoE standard

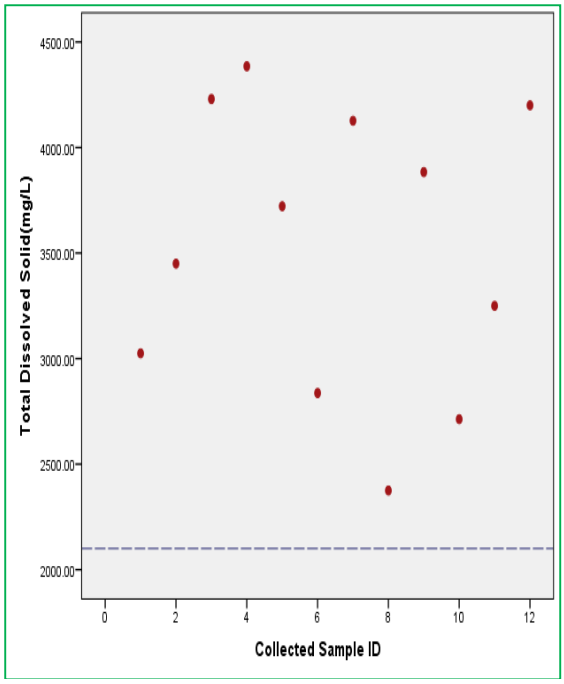

Figure 2- TDS of the samples with DoE standard

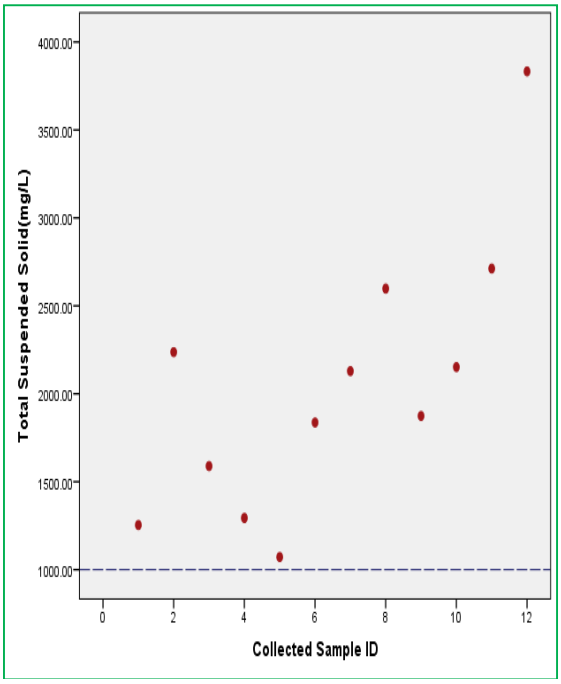

Figure 4- TSS values of the samples with DoE standard

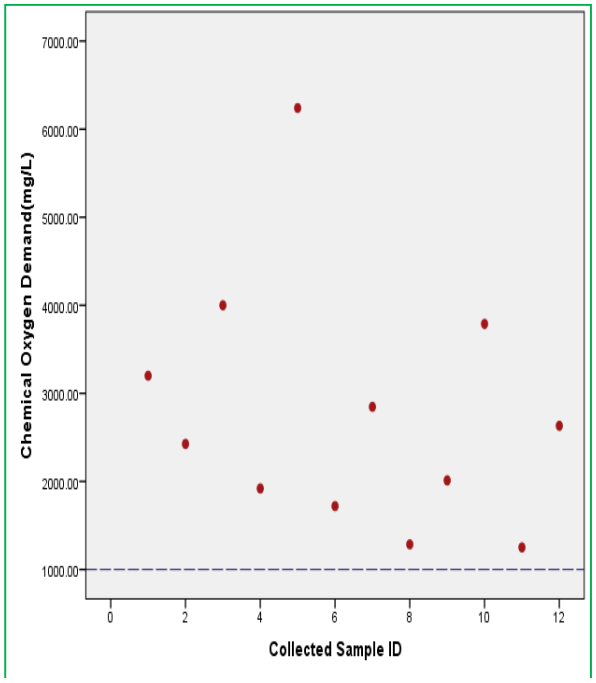

Figure 3- COD values of the samples with DoE standard

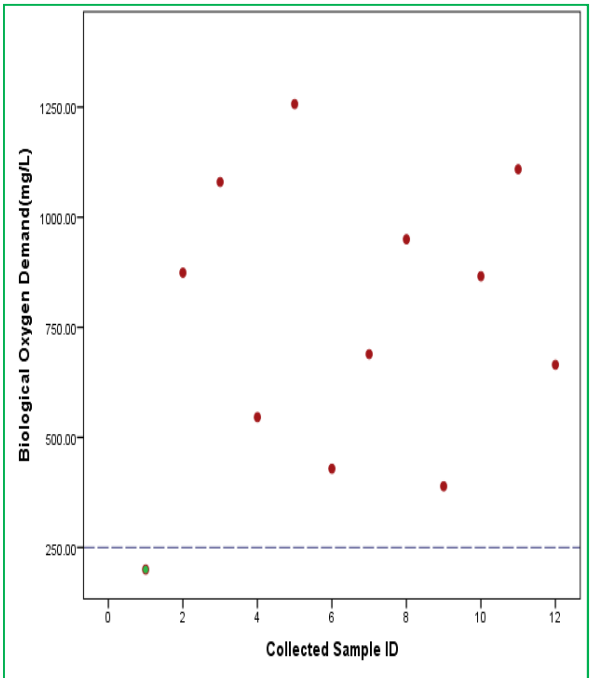

Figure 5- BOD_5 values of the samples with DoE standard

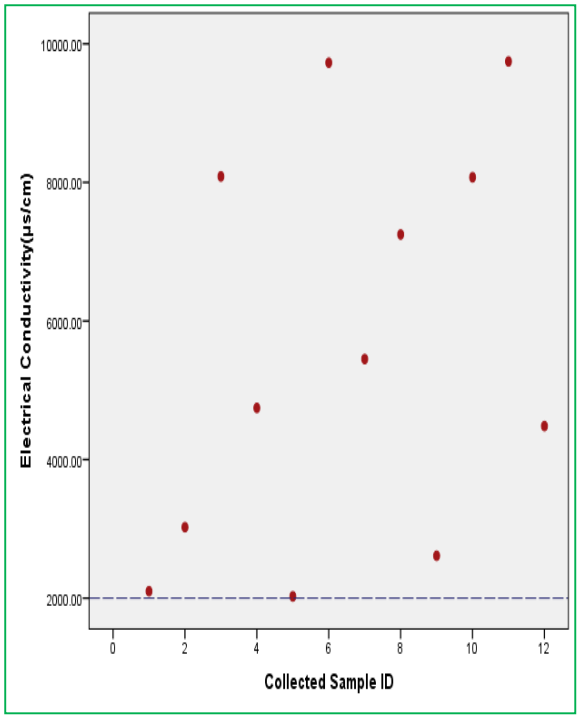

Figure 6- Electrical conductivity of the samples with DoE standard

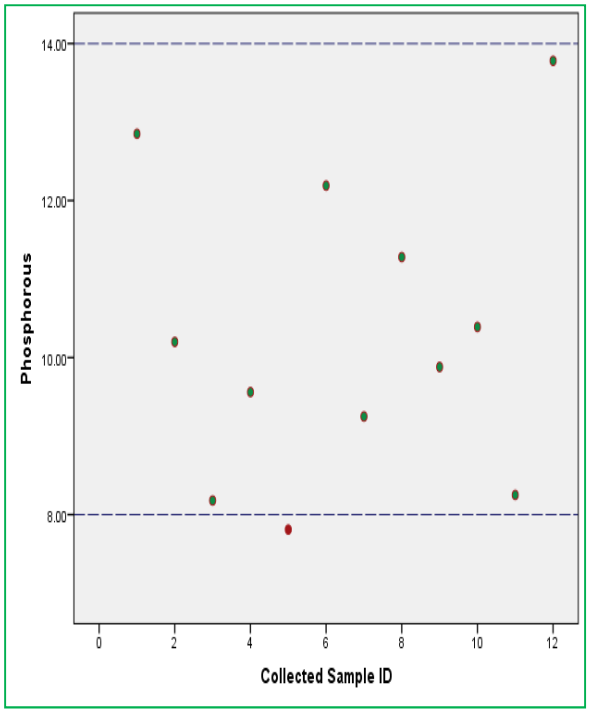

Figure 8– Phosphorous values of the samples with DoE standard

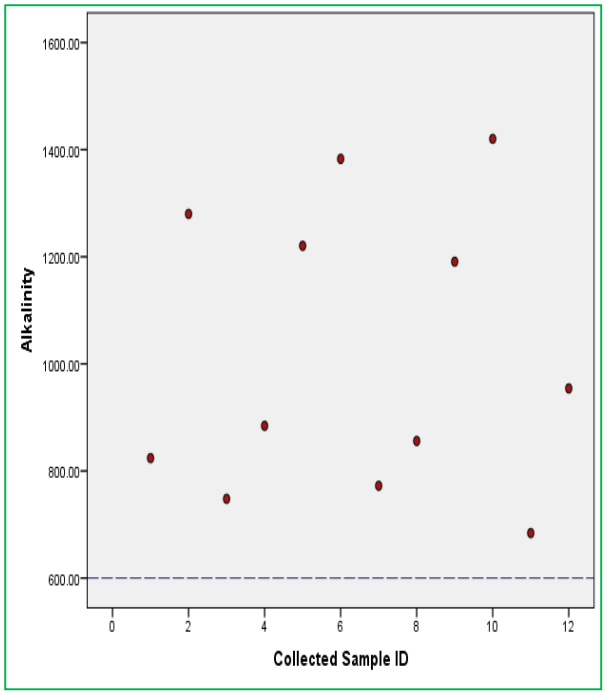

Figure 7- Alkalinity values of the samples with DoE standard

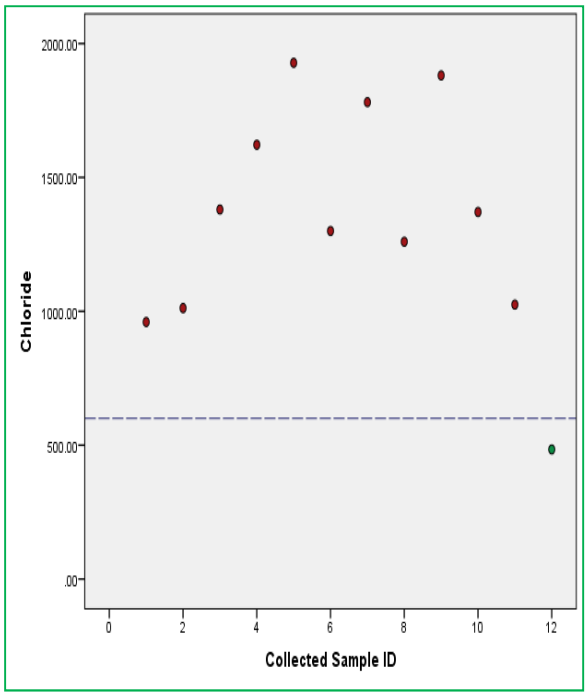

Figure 9–Chloride values of the samples with DoE standard

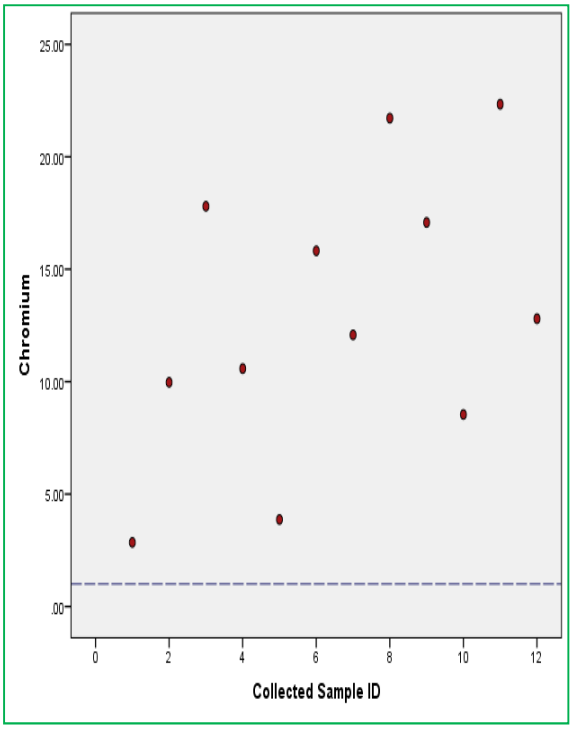

Figure 10- Chromium values of the samples with DoE standard

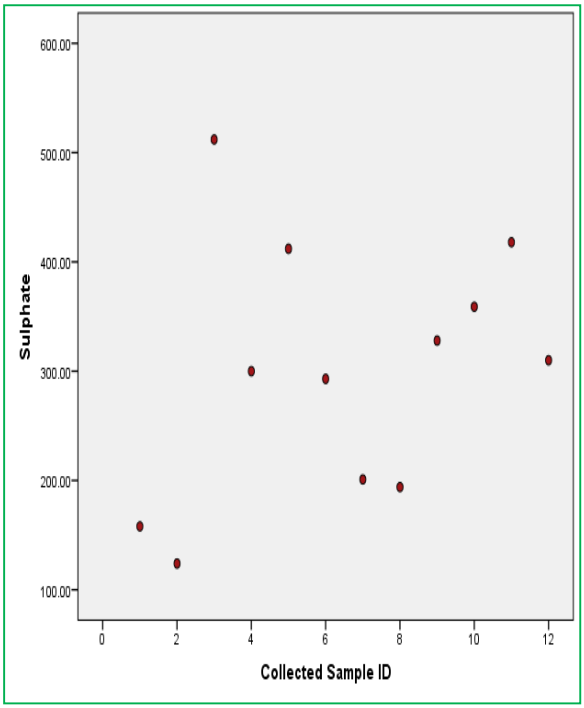

Figure 12- Sulphate values of the samples with DoE standard

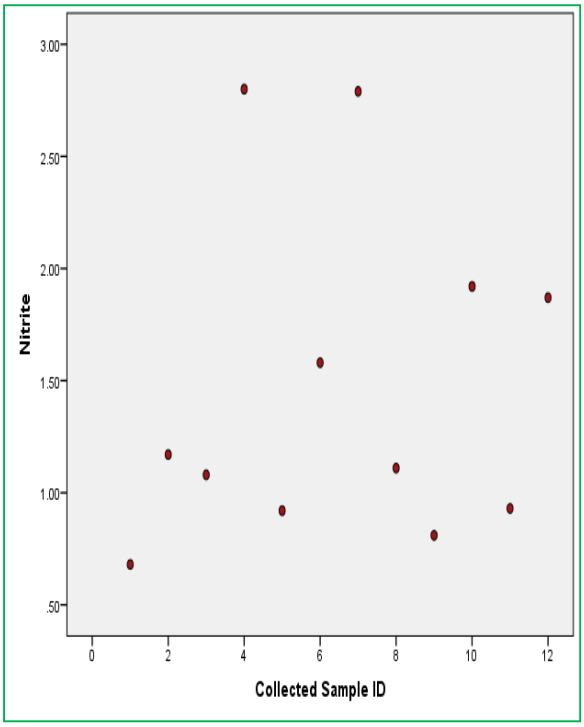

Figure 11- Nitrite values of the samples with DoE standard

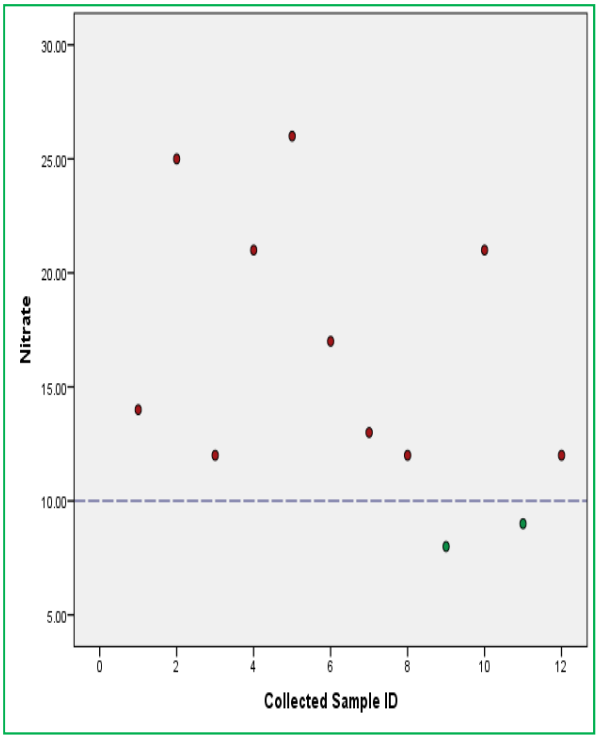

Figure 13- Nitrate values of the samples with DoE standard

Table4. Experimented Average Values of the Parameters with DoE Standards for Bangladesh

Sr. No.	Parameters	Values of experiments	Standard value
1	pH value	6.56	6-9
2	TSS (mg/L)	2048.42	150-500
3	COD (mg/L)	2776.83	200 -400
4	TDS (mg/L)	3516.5	2100
5	BOD (mg/L)	754.5	50-250
6	EC (µs/cm)	5409.50	1200
7	Alkalinity (mg/L)	1018.08	500
8	Phosphorous (mg/L)	10.35	8-15
9	Chlorides (mg/L)	1333.67	600
10	Nitrite (mg/L)	1.47	-
11	DO (mg/L)	1.58	4.5-8
12	Sulfate (mg/L)	300.75	-
13	Nitrate (mg/L)	15.83	10
14	Chromium (mg/L)	12.95	0.5-1.0

4.0 Conclusion:

This research illustrates that the values of the parameters of the effluent are enormously deviated from the standards. For examples, the average value of BOD_5 is about seven times than its standard value and chromium is about twelve times. Also other parameters remain in worst conditions. Because of missing of suitable effluent treatment plants, the untreated effluent gets mixed with the river of Buriganga and surrounding areas terribly which affects human lives, plants, aquatic creatures and also total environment unfavorably. The ensuring of special treatment plants and other necessary steps must be taken as soon as possible for protecting the environment of the area from destroying.

5.0 Acknowledgement:

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