Comparison of different parameters of four selected industrial effluents in BSCIC industrial estate, Begumganj, Noakhali, Bangladesh

Tanuja Barua, Md Mehedi Hasan Munna, Sujit Kumar Roy

Abstract- The present study was executed at BSCIC (Bangladesh Small and Cottage Industries Corporation) industrial estate, Begumgonj, Noakhali to examine the status of important criterions of industrial effluents (physical, chemical and trace metal concentrations) from four types of industries in that area, namely food, printing and packaging, pharmaceuticals and metals. The collected effluent samples were from three different discharge points, such as exact point of discharge, mixing point and afield points from randomly selected industries. Then pH, DO (dissolved oxygen), TDS (total dissolved solids), BOD (Biological Oxygen Demand), EC (electrical conductivity), metal ionic concentration etc. of the collected effluent samples were estimated and analyzed. From the collected data, the result showed that effluents from metal industry were causing maximum pollution, showing the highest EC, TDS, SO_4^{2-} concentration and the lowest DO and BOD concentrations. Comparatively, pharmaceutical industry was initiated to be less contaminated and most of the parameters regarding the samples collected from this industry showed that the aforementioned parameters are close to the desirable level due to implementation of effluent treatment plant (ETP) facility in their industry. This paper argues that it is essential to establish a waste water management system to treat and process waste water by implementing suitable mitigation strategy before discharging the material into the environment so that ecological balance can be maintained and human and aquatic life are not endangered due to increasing industrial activities.

Keywords: Industrial effluents Parameters, ETP, EC, TDS, BOD, DO and Heavy metals.

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1. INTRODUCTION

Bangladesh situated in the northeastern part of South Asia between 20°34′ to 26°38′ north latitude and 88°01′ to 92°41′ east longitude. Among the least developed countries Bangladesh is one of them with a low resource base under high population pressure and a low land to man ratio. Rapid urbanization and industrial development during last decade have raised some serious concerns for the environmental health in countries like Bangladesh [1]. As a result, sources of pollution increase with urban development, and it affects the environment in different ways. Increased discharging of large volume of different categories of hazardous effluents into the surrounding water bodies causes serious concerns for environment [10]. Industrial wastes are one of the leading sources of pollution in all environments and require instant treatment before they can be safely discharged into the sewage system [5]. Soil and environment are under extensive pressure because of the rapid and continuous industrial expansion and discharge of hazardous effluents. There is still not sufficient awareness visible among the masses regarding this matter, which is a globally important issue.

- *Tanuja Barua, Department of Environmental Science and Disaster Management, Noakhali science and technology University, Bangladesh, PH-. E-mail: tanujaifescu28@gmail.com*
- *Md Mehedi Hasan Munna, Department of Environmental Science and Disaster Management, Noakhali science and technology University, Bangladesh,PH-01715256698. E-mail: mhmunna0094@gmail.com,*
- *Sujit Kumar Roy, Department of Environmental Science and Disaster Management, Noakhali science and technology University, Bangladesh, PH-01748985407, E-mail-sujitroy.bejoy@gmail.com*

Developing countries, such as one like Bangladesh, are now in a vulnerable position in this regard [11]. The DoE (Department of Environment) identified many industries across the country that are causing pollution, which have no treatment facilities for safe discharge of effluents and wastes. These highly hazardous materials are being discharged directly to the adjacent soil and water bodies [7]. The existing propensity of industrialization and urbanization depletes the non-renewable resources and affects both the soil and surface water quality through indiscriminate release of industrial effluents, hazardous and solid wastes. This finally leads to major environment related threats to the existence of life on earth of human kind [13].

Industrial effluents (IEs) are inevitable consequences of industrial productivities. With the expansion and increase of these activities, IEs are also being produced proportionately, with most of the industrial effluents getting directly dumped into the nearest water bodies, river, lake, stream, etc. and polluting surface water resources [8]. In the production and manufacturing process of these industries, various different categories of solid and liquid wastes are generated that may contain considerably toxic substances. If those substances are dumped into the environment without prior proper treatment, this may lead to severe environmental damages. This will irretrievably degrade soil productivity and have adverse impact on crop production in the surrounding land. A noteworthy example is modifications of the toxic substances and their concentrations in bean and wheat plants [17].

In Bangladesh, most of the industrial areas situated in near the densely populated zones and the rapid growth of industries has generally been unplanned without taking the

issue of environmental protection into significant consideration. BSCIC (Bangladesh Small and Cottage Industries Corporation) industrial estate, Begumganj is one of the newly built such industrial clusters, where rapid unplanned industrial expansion has led to serious pollution through discharge of industrial effluents [6] to the nearest canal named Noakhali khal. Due to increasing number of food and beverage, metal, pharmaceutical and other industries in this region, a large quantity of industrial chemicals and waste products are being generated every day, which are released into the adjacent water body. As a result, the water, which could be used for land irrigation, fish yield or recreation, is becoming greatly polluted through the addition of these toxic substances. Categories of such industries include printing and packaging, spinning, pharmaceutical, food manufacturing etc., but only one of them has effluent treatment plant (ETP) installed. Indiscriminate discharge of effluents by these industries in

and around BSCIC industrial area is degrading the quality of the water of the adjacent Noakhali khal. The dumping site connected to the river emits noxious odor, and has great impact not just on the water but also upon the soil properties as well. This study has consequently been conducted to evaluate different significant environmental parameters of effluents in the BSCIC industrial area, Noakhali, which is really essential for preserving environment and also for identifying different environmental problems in that region.

2. Material and Methods

2.1 The study area

BSCIC industrial estate is located at Mir Warishpur union under Begumgonj upazila, which is approximately within latitude at 22°56'57.0" N and longitude 91°06'18.6" E. It is situated by Dhaka-Noakhali highway locally called as 'BSCIC' (Banglapedia, 2008).
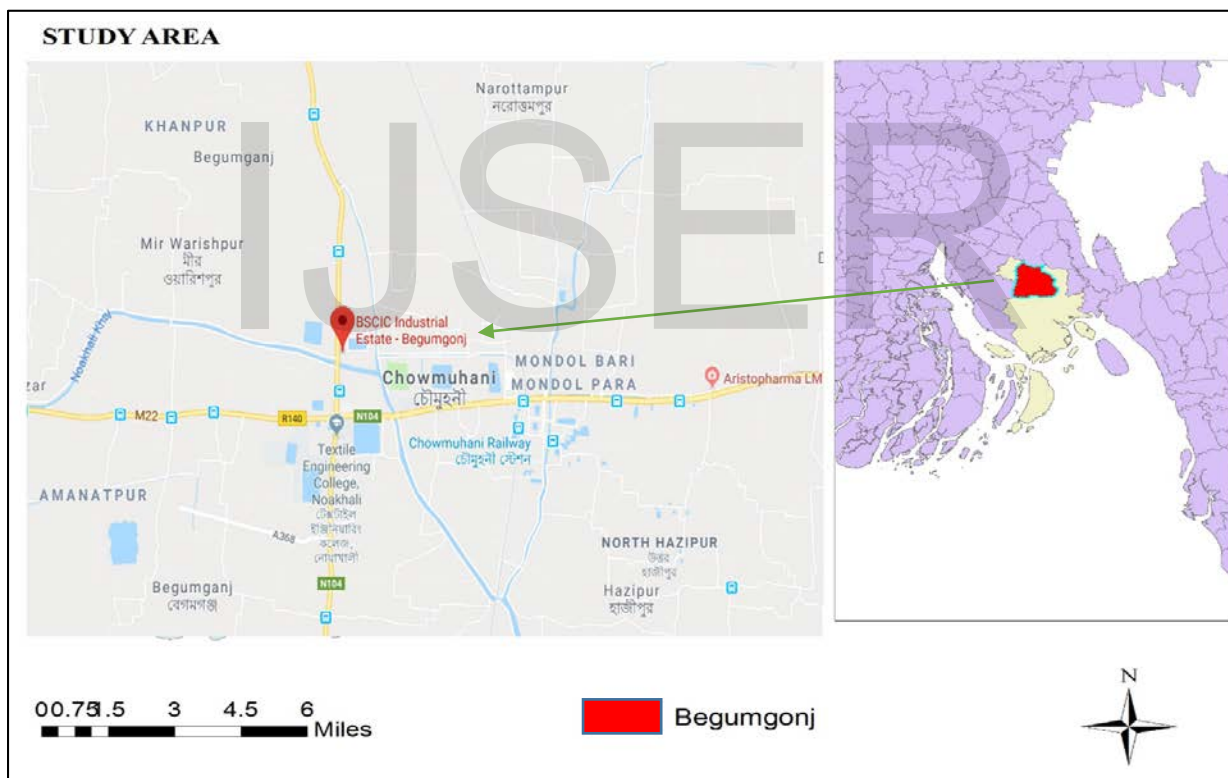

Fig. 1 Map showing the study area of Begumganj, Noakhali (Source: Google map).

Noakhali Khal is linked with the study area as the industrial effluents meet this canal after flowing for approximately 30–50 m through the effluent carrying drain. This study is conducted in the industrial area effluent channel from four different industries' outlets. This study is designed to assess the effluent parameters of four selected industries (food, printing, pharmaceuticals and metal) of the BSCIC industrial area. Discharge of large amount of industrial effluent may

affect adversely not only the environment but also the farmers in this area.

2.2 Design of sampling

This study includes sampling of effluents from 3 specific points, viz. discharge point (before mixing), mixing point (where chemicals spread into nature and similar sort of industries) and universal point (where diverse types of

effluents get mixed with each other and spread far away). All the samples were collected from the specific discharge point, 5 m away from the discharge point, and 50 m away from the discharge point from four different types of selected

industries at BSCIC industrial estate. The aforementioned industries mainly discharge their untreated effluents into the canal.
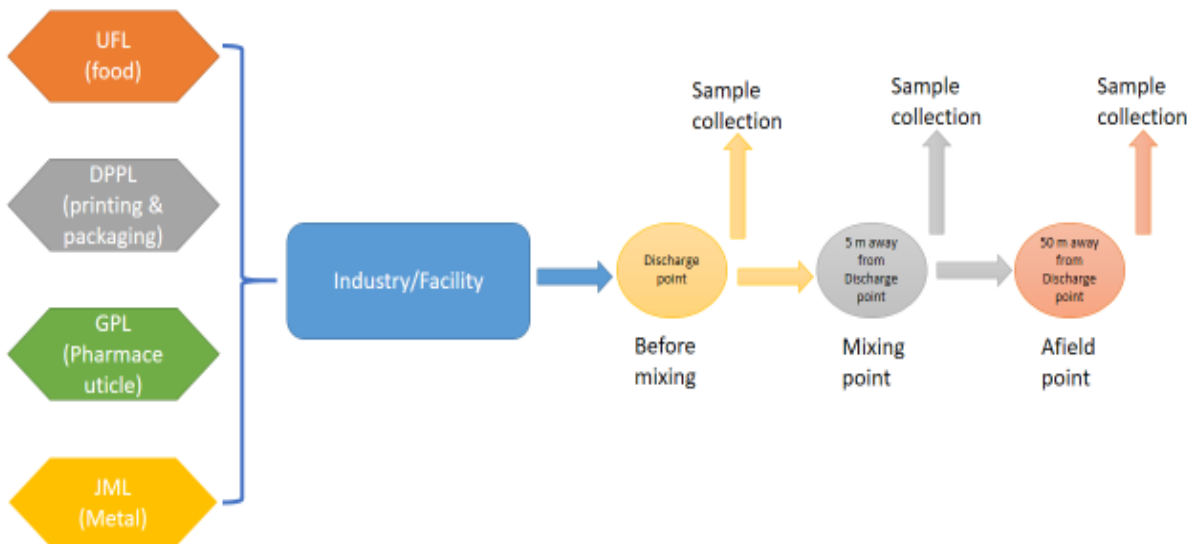

Fig. 2 Schematic representation indicating the selected sampling sites.

2.3 Sample collection and preservation

The four types of effluent discharging industries selected from the BSCIC industrial estate for assessment are Unifood Limited (UFL), Dream Printing and Packaging Limited (DPPL), Globe pharmaceuticals Limited (GPL) and Jamuna Metal Limited (JML). Plastics bottles were first washed thoroughly with soda water and distilled water before collecting the water samples in order to confirm that they are absolutely free from any unwanted hazardous material or micro-organisms. The samples were stored in the bottles in such a way that they filled the whole volume of the bottle, and the bottles were sealed so that the sample inside is isolated from the surrounding environment. Pertinent information regarding each sample, such as date of collection, location of collection etc. were recorded, and all the bottles were separately labeled with specific identification number. Then the bottles were preserved at below 4^0 C for testing the target parameters in the laboratory of Soil Resource and Development Institute (SRDI), Noakhali, Bangladesh.

2.4 Required apparatus and reagents

The apparatus used in laboratory analysis of the effluents are pH and DO meter, Sension 156 Portable multi-parameter meter, 250 and 50 ml beaker, pipette, stirrer and spectrophotometer. The necessary reagents are distilled water, seed (mixed micro-organisms solution), Na_2O_3, H_2SO_4,

potassium, dichromate, Hg_2SO_4, Ag_2SO_4, KHP, standard buffer solution, potassium 1 and chloroform.

2.5 Analytical procedure

Color, odor & pH were determined by taking effluent sample in a clean glass test tube. The color was evaluated visually. The odors of all three waste water samples were noted at 28^0C. pH was measured electrometrically using the pH meter (no. I-1000). Thus it was used by removing the safety cap from the tip of probe. The probe was then thoroughly washed with the sample water first, and then stirred into sample beaker until the result was displayed. EC depends on the presence of ions, their total concentration, mobility, valence of the ions and temperature. EC was determined by a conductivity meter following the procedure demonstrated by Richard [8]. The TDS (Total Dissolve Solids) of the waste samples were determined by using a TDS meter (no. I-1100). Then, we took a requisite amount of waste water sample in a beaker, probe of the TDS meter was immersed, making sure that the sensor was fully covered until the reading was stabilized [7]. To measure dissolved oxygen (DO) in water, 100 mL of the collected samples was taken in a beaker. DO of the samples was measured with the help of a DO meter (YSI, Model 58, USA).To measure biochemical oxygen demand (BOD), **t**he sample was filled in six BOD bottles. After that we took one ml Allyl-thiourea that was added into each bottle. The amount of the dissolved oxygen was determined by titration method as described earlier, and the mean of the

3 readings was noted as D_1. The other three bottles were incubated in an incubator in dark at 200^0 C for 5 days. Dissolved oxygen readings in the incubated samples were estimated by titration, and the mean reading was taken as D_2. The BOD of the wastewater was determined by using the following formula:

BOD (mg/1) = $(D_1- D_2)$/ (Amount of the sample taken into the BOD bottles)

We determined phosphate concentration of the water samples calorimetrically by stannous chloride ($SnCl_2$) using a method in compliance with the procedure outlined by APHA (American Public Health Association, 1995). In this method, firstly stannous chloride ($SnCl_2.2H_2O$) reagent was used as a reducing agent, which developed molybdophosphoric blue complex with sulphomolybdic acid. After that exactly 10 ml water sample was taken in a 50 ml volumetric flask followed by the addition of 2 ml sulphomolybdic acid and 2-3 drops of stannous chloride ($SnCl_2.2H_2O$) solution. Finally the color intensity of the solution was measured at 660 nm wavelength with the help of a spectrophotometer (Labtronics, LT-31, India) within 15 minutes after the addition of stannous chloride.

To determine potassium content of the water samples separately, we used flame emission spectrophotometer (Jenway PEP7, UK) using potassium filters. The samples were aspirated into a flame and the intensity of light emitted by K at 768 nm wavelength was directly proportional to the concentration of K, present in the waste water samples. The percentage of emission was recorded following the method. To determine concentration of sulphate, firstly we measured 100 mL or suitable portion of the sample into a 250 mL Erlenmeyer flask. Then we added 5 mL of conditioning reagent and mixed the solution by a magnetic stirrer. A spoonful of barium chloride crystals was added to the solution and started recording time. After that we stirred uniformly for one minute. After stirring, we poured some of the solution into the absorption cell of the photometer, and measured the turbidity at 30 second intervals for four minutes. Usually maximum turbidity occurs within two minutes and the reading remains constant thereafter for 3 to 10 minutes. So, we took reading around the time when maximum turbidity occurs, which is four minutes.By using this data, we formulated a calibration curve. The standards were prepared at 5 mg/L increments within 0-40 mg/L sulphate range and their turbidity or absorbance was read. Absorbance versus sulphate concentration was plotted and a curve was obtained. Finally, we determined the absorbance for a given sample, and the concentration of sulphates in the solution was determined with the help of the calibration curve.

In order to determine presence of chlorine, at first, 1 ml of sample of waste water was taken into a 10 ml test tube and ortho-tolidine indicator was added to it. Finally, the presence or absence of chlorine was determined by the formation of yellow color. The amount of iron present in the waste water samples was determined by adding 5 ml of hydrochloric acid, few drops of potassium permanganate (0.2 N) solution and 5 ml of 2% potassium thiocyanate solution into 100 ml of water sample. As a result, brown color was formed in the resulting solution, which was then compared with standard iron stock solution.

2.6 Data Analysis

At the end of data collection, data were compiled, tabulated and analyzed. Statistical analysis was performed on the data generated from the chemical analysis. SPSS and Microsoft Office Excel software package were used for data analysis. The other descriptive statistical measures viz. range, mean, standard deviation (SD) etc. were calculated for categorization and numerical quantification of the variables.

3. Results and Discussion

3.1 Basic information of the study area

To evaluate the pollution content, effluent samples from four different types of selected industries were analyzed for various physical and chemical parameters. The chemical parameters of the water around the industrial site obtained from the analyses are presented in the tables 1 and 2. Water quality for agriculture is worth evaluating, because it has a remarkable impact on soil, crop and human life. Therefore, it is necessary to determine the quality of waste water and its possible effects due to long-term irrigation. The general statistics of major and trace element geochemistry of industrial effluent were collected from BSCIC industrial estate of Begumgonj, Noakhali and compared with the standard values of the industrial effluent.

3.1.1 Physicochemical properties of water sample pH

The mean pH values of effluent samples collected from the selected points of different industries varied from 5.79 to 8.21 with a mean value of 6.88, indicating slight acidity of water. From the results, it was observed that pH value considerably varied in different locations. It was observed that pH was highest (8.21) at the third point of printing and packaging industry, whereas lowest (5.79) at the third point of the food and beverage industry. The acceptable range of pH for irrigation water is from 6.5 to 8.5 (fig. 3). So, the result showed that the pH of discharged water from BSCIC industrial area has low impact on long term irrigation practice.
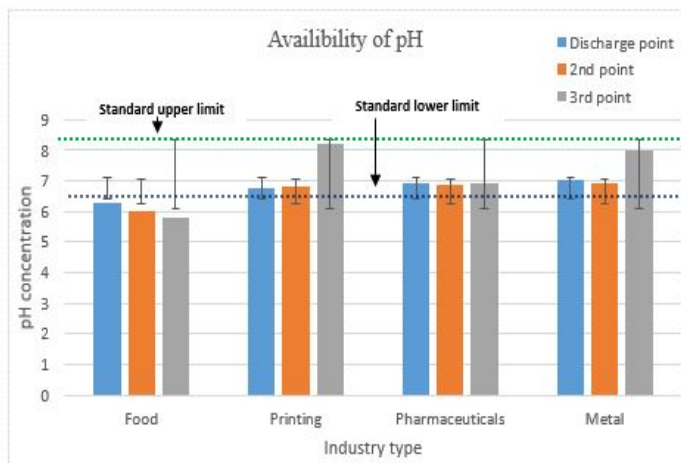
Fig. 3 pH value of industrial effluents samples.

3.1.2 Electric Conductivity (EC)

It was observed that electric conductivity (EC) was highest (5870 μS/cm) in the second point of metal industry, whereas it was lowest (344 μS/cm) in the first point of food and beverage industry. Among the different industries, food and pharmaceuticals industries showed lower concentration at all three positions. In the metal and printing & packaging industries, EC showed much higher value in all the positions (fig. 4).
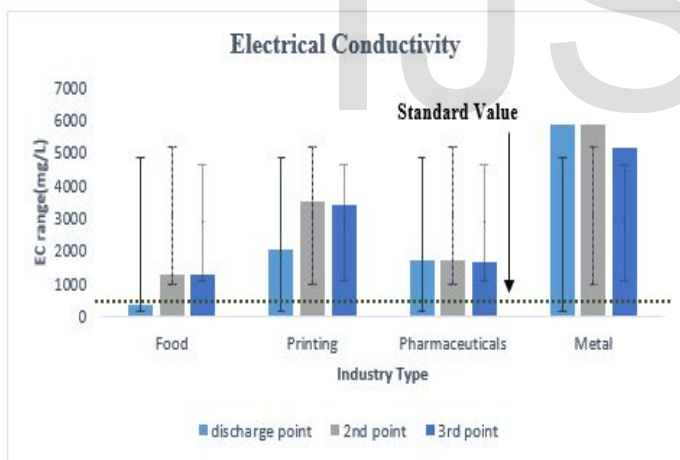

Fig. 4 EC levels of effluent from different industries studied.

However, EC of most of the categories of industries exceeded the standard value (750 μS/cm). The study observed that the level of EC lies considerably differently among the different categories of industries and sampling points. EC of the water depends on the water temperature: the higher the temperature, the higher the EC would be.

3.1.3 Total Dissolved Solids (TDS)

The experiment reveals that the maximum TDS (2930 mg/L) was observed in the discharge point of metal industry and the minimum (170 mg/L) was found in the discharge point

of food and beverage industry, where the average value was 1471.75 mg/L. In the third position of printing & packaging industry, TDS was found to be 1730 mg/L. However, TDS of food, printing & packaging and pharmaceutical industries remained below the standard value (2100 mg/L), whereas metal industry (2773 mg/L) exceeded the standard limit (fig. 5).
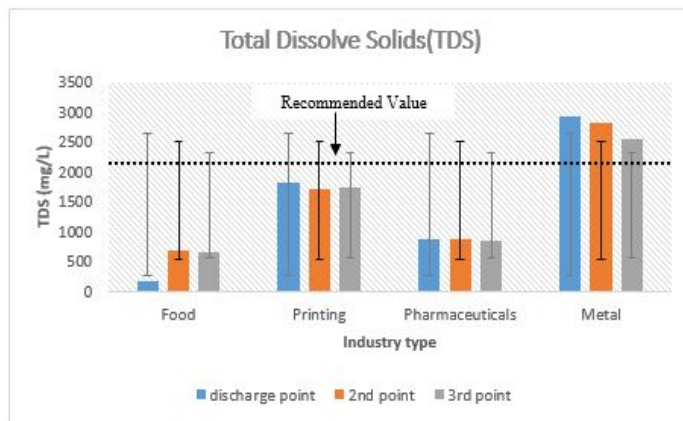

Fig. 5 Normal total dissolved solid (TDS) levels in industrial effluents.

If the TDS level is greater than 1000 mg/L, then it is commonly objectionable or causes fetid taste. When the concentration of dissolved solids is maximum, it intensifies the density of water, affects osmoregulation of fresh water creatures and reduces solubility of gases and applicability of water for industrial and others water consumptive purposes.

3.1.4 Dissolved oxygen (DO)

The DO of all collected effluent samples was within the range of 0.34 to 3.17 mg/L with an average of 1.22 mg/L (Table 1). The study observed that DO value was not varying considerably among different categories of industries but significant variations exist among the sampling points except steel industry. DO reading of all categories of industries was below the level of standard value (4.5-8 mg/L). DO levels of pharmaceutical industry in its discharge point is highest (3.17 mg/L) and lowest value (0.34 mg/L) was obtained from the third point of food and beverage industry effluents (fig. 6). Among the three points of sample collection sites, the second point (3.17mg/L) of pharmaceutical industry is closer to optimum level. In the third point, DO concentration decreased and reached far from the optimum level. Low DO concentrations in fresh water aquatic systems indicate high pollution level in water. Lower DO level in the effluents may be due to presence of chemically oxidized and biodegradable organic compounds in effluents.

Table 1: Physicochemical characters of effluent sample

Industry Type	Sampling Point	Sample Cd.	Temp (ºC)	Color	Odor	pH	EC (µS/cm)	TDS (mg/L)	DO (mg/L)	BOD (mg/L)
Food and Beverage	Discharge	S_1	29.5	Brown	Pungent	6.30	344	170	1.24	123
	5m From Discharge point	S_2	29.7	Black	Pungent	6.02	1265	675	0.57	118
	50m From Discharge point	S_3	29.5	Black	Pungent	5.79	1282	660	0.34	113
Printing & packaging	Discharge	S_4	29.9	Black	Trace	6.78	2045	1820	1.62	37
	5m From Discharge point	S_5	29.5	Black	Trace	6.81	3500	1720	2.24	41
	50m From Discharge point	S_6	29.4	Dark Black	Trace	8.21	3420	1730	2.53	35
Pharmac-euticals	Discharge	S_7	29.3	Brown	Pungent	6.92	1737	871	0.45	58
	5m From Discharge point	S_8	29.5	Black	Trace	6.88	1693	862	3.17	55
	50m From Discharge point	S_9	29.2	Black	Pungent	6.94	1674	833	0.47	54
Metal	Discharge point	S_{10}	29.4	Black	Trace	7.05	5840	2930	1.08	41
	5m From Discharge point	S_{11}	29.1	Black	Pungent	6.90	5870	2830	0.55	37
	50m From Discharge point	S_{12}	29.2	Dark Brown	Trace	7.98	5140	2560	0.36	35
		Avg.	29.43			6.88	2817.5	1472	1.22	62.16
		Max	29.9			8.21	5870	2930	3.17	123
		Min	29.1			5.79	344	170	0.34	34
		SD	0.22			0.69	1904.5	904.99	0.96	57.54

Table 2:

Concentration of PO43-, K+, CL- and SO42- (mg/L) present in effluents

Industry Type	Sampling Point	Sample ID	Sample Code	P (mg/L)	K (mg/L)	Cl (mg/L)	SO₄ (mg/L)
Food and Beverage	Discharge	1	S_1	0.03	30	104.93	3.12
	5m From Discharge point	2	S_2	0.32	60	297.78	19.64

| Industry	Location						
	50m From Discharge point	3	S_3	0.20	344	323.31	7.34
	Discharge	4	S_4	0.15	152	1077.68	11.1
Printing & packaging	5m From Discharge point	5	S_5	0.71	152	986.93	11.4
	50m From Discharge point	6	S_6	1.25	156	969.91	10.14
	Discharge	7	S_7	1.02	112	428.24	18.5
	5m From Discharge point	8	S_8	1.09	104	436.75	19.78
Pharmac-euticals	50m From Discharge point	9	S_9	2.06	102	1748.35	15.92
	Discharge	10	S_{10}	0.80	204	1053.58	19.08
	5m From Discharge point	11	S_{11}	0.42	196	1038.53	24.48
Metal	50m From Discharge point	12	S_{12}	0.23	144	1538.53	16.78
			Avg.	0.69	163	781.19	14.77
			Max.	2.06	344	1748.35	24.48
			Min	0.03	30	104.93	3.12
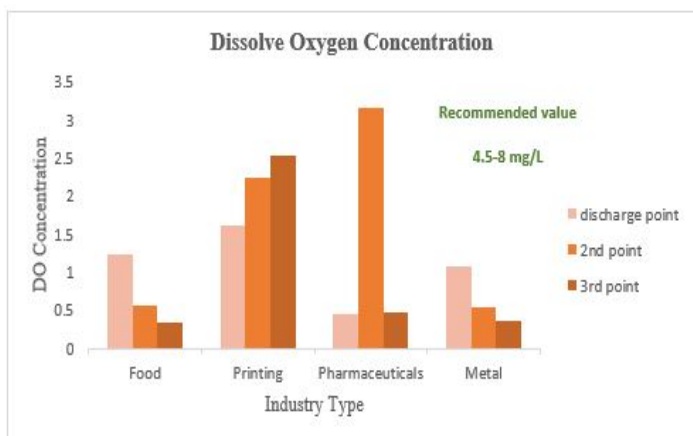
Fig. 6 DO levels of effluent from different industries studied.

As dissolved oxygen level in water drops below 5.0 mg/L, aquatic life is put under stress. Standard value of DO varies from 4.5-8 mg/L, but from this study we did not see any industry discharging close to optimum level, rather the result was quite contrary to what is actually desirable. For example, DO level of Uni food limited was found to be 0.34 mg/L, which is quite alarming. Effluents from Dream Printing & packaging industry were moderately treated, as its average DO reading was found to be 2.72 mg/L, which is closer to the standard value. From the study, it was found that all of the industries discharged untreated or under-treated effluents, wherein this study did not observe any industry discharging close to the desirable optimum level.

3.1.5 Biological Oxygen Demand (BOD)

The study finds that the level of BOD did not vary considerably among printing & packaging, pharmaceutical, and metal industries, but there exists substantial variations in all sampling points of food and beverage industry. From the experiment, the highest BOD (123 mg/L) was found in the first point of food and beverage industry, and the lowest (34 mg/L) was found in the third point of metal industry, whereas the average value obtained was 62.16(mg/L). In

every point, BOD level of food and beverage and pharmaceutical industry exceeded standard value which is 50 mg/L (fig. 7).
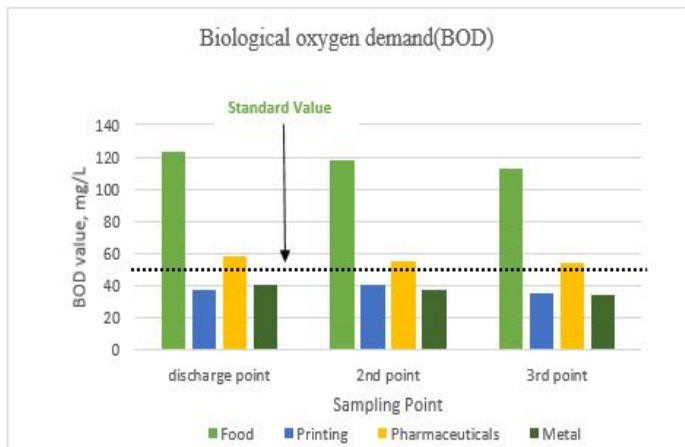

Fig. 7 BOD levels of effluent from different industries studied.

However, almost each of the positions of printing & packaging and metal industry, BOD is found to be around optimum level. Higher BOD level is a signature of more bacterial activities, and in such cases bacteria contributes to the depletion of the available DO required for the survival of other aquatic organisms (e.g. fishes). Numerous types of organic chemicals may be used by micro-organisms in the water bodies as principle sources for energy and chemicals for growth, which can cause breakdown of organic constituents to quite simpler compounds and this may eventually results in inorganic ashes and gases. These biochemical reactions contribute in application of oxygen dissolved in the water promulgating a high BOD. This study showed that UFL and GPL discharged effluents, which were either untreated or not properly treated. Effluents from DPPL and JML were properly treated as its BOD reading is closer to the standard value (50 mg/L). However, UFL discharged huge amount untreated waste. Here, BOD crossed the standard limit and so effluents need to be treated.

3.2 Ionic properties of water sample

3.2.1 Phosphorous

The phosphate concentration of the test samples collected from the major polluting areas of BSCIC industrial area varied from 0.03 mg/L to 2.06 mg/L. The mean value of PO4 in all collected water samples was 0.69 mg/L. Among the collected samples, the highest content of PO4 (2.06 mg/L) was recorded in the third point of pharmaceutical industry as the effluent of third point mixed with other industries effluents and the lowest value (0.03mg/L) was obtained from the discharge point of food & beverage industry (fig.8).
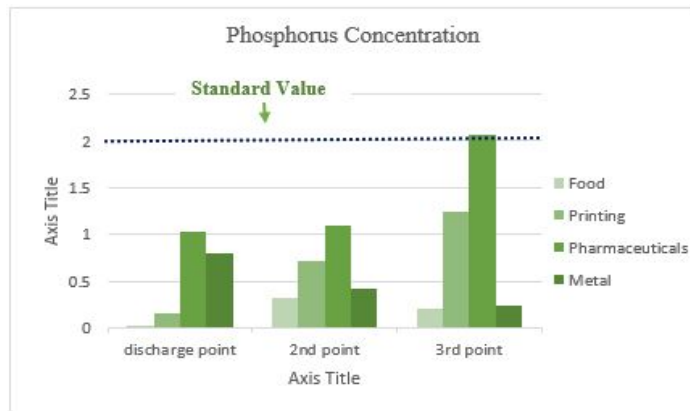

Fig. 8 Phosphorus levels of effluent from different industries studied.

Maximum permissible limit of PO_4 in industrial waste water was found 2.00 mg/L. Most of the samples (91.66%) were lower than the permissible value.

3.2.2 Potassium

Water for irrigation should satisfy the needs of soil and plants of the area for normal growth and crop production. The concentration of K present in the effluent samples collected from the major polluting areas of BSCIC industrial area, Begumganj varied from 30 to 344 mg/L with the mean value of 144 mg/L. Among the collected samples, the highest content of potassium (344 mg/L) was recorded in the third point of food & beverage industry and the lowest value (30 mg/L) was obtained from the discharge point of food & beverage industry (fig. 9).
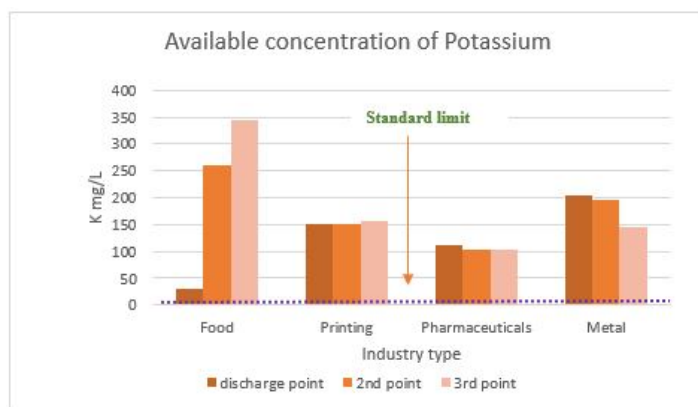

Fig. 9 Available concentration of potassium from different industries studied.

The recommended limit of potassium in irrigation water is 2.0 mg/L. In the study area, all of the water samples exceeded the recommended limit.

3.2.3 Chloride (Cl-)

The chloride content of the test samples collected from four different types of selected industries of BSCIC industrial area varied from 104.93 mg/L to 1748.35 mg/L. The mean value of chloride in all collected water samples was 781.19 mg/L (fig. 10).
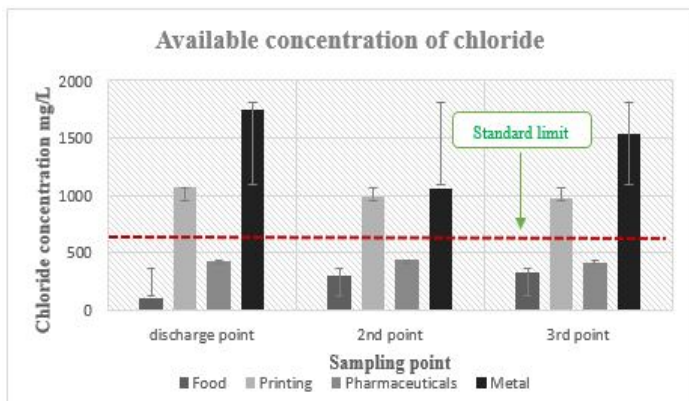

Fig. 10 Available concentration of chloride from effluent samples.

Among the collected samples, the highest content of chloride (1748.35 mg/L) was recorded at the first point of Jamuna metal industry and the lowest value (104.93 mg/L) was obtained from the discharge point of food & beverage industry. However, the level of chloride in effluents of Unifood limited and Globe pharmaceuticals were within the standard value (600 mg/L), whereas the level of chloride in effluent from Dream printing & packaging and Jamuna metal industry exceeded the recommended limit. As the maximum recommended limit of chloride concentration exceeded in both DPPL and JMI, it usually pollutes the nearby water stream (Noakhali khal) frequently.

3.2.4 Sulphate

Available concentration of sulphate from four different industries varied from 3.12 mg/L to 24.48 mg/L with an average value of 14.77 mg/L. The result showed that sulphate concentration was highest (24.48 mg/L) in the second position of metal industry, whereas it was lowest (3.12 mg/L) in the first position of the food and beverage industry (fig. 11).

Among the three positions of sampling points, all categories of selected industries showed lower concentration. However, sulphate concentration of all the categories of industries was found under the standard value (600 mg/L).
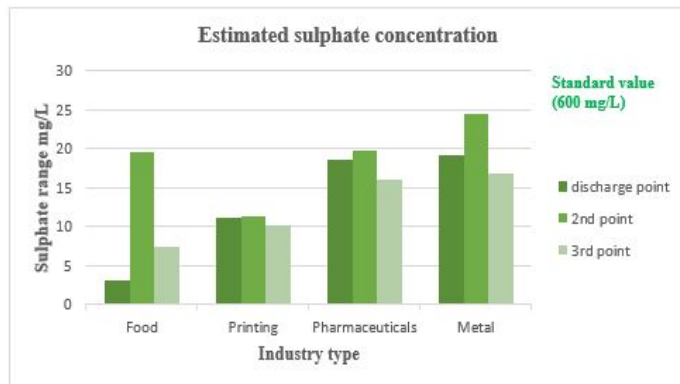

Fig. 11 Available concentration of sulphate from waste water samples.

3.2.5 Iron (Fe)

The iron (Fe) content of the samples collected from selected industries of BSCIC industrial area varied from 0.94 mg/L to 5.24 mg/L. The mean value of iron (Fe) in all collected water samples was 2.94 mg/L. This study showed that that concentration of Fe was highest (5.24 mg/L) in the first position of food & beverage industry, whereas it was lowest (0.94 mg/L) in the second position of food and pharmaceutical industry. Among the three positions of sampling points, pharmaceuticals industry showed lower concentration (fig. 12).
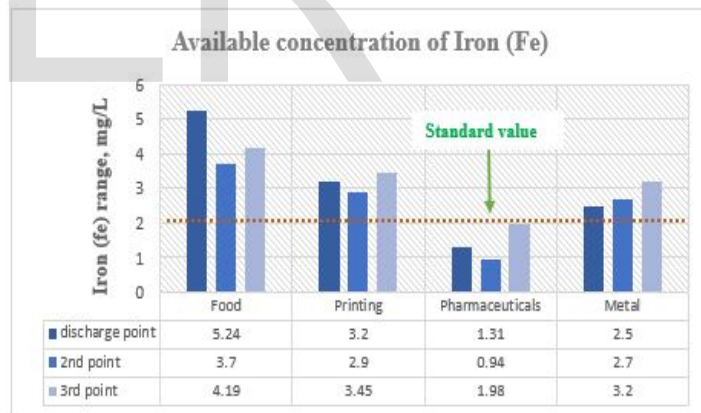

Fig. 12 Estimated concentration of iron (Fe) from 4 different types of industries.

In the food and printing & packaging industries, iron (Fe) showed higher value in the first position as they used huge amount of Fe rich chemicals but it got reduced at the second position of pharmaceuticals industry because of their ETP facility. The Fe concentration of the metal industry remained near the optimum level. However, iron (Fe) concentration of all of the categories of industries excluding pharmaceuticals industry exceeded the standard value (2 mg/L).

4. Conclusion

This study represents that within the selected categories of industries at BSCIC industrial estate, Begumganj, effluents from four types of industries viz. food and beverage, printing & packaging, pharmaceuticals and metal industries were highly adulterated due to the absence of ETP in this industrial area. Among these four types of industries, food and metal industries showed maximum level of pollution. Effluents from food and metal industries are getting mixed with drain water and polluting water system of nearby Noakhali Khal. On the contrary, pharmaceutical industry acts as a comparatively lesser polluting agent due to its ETP facility and pre-treatment of waste water before discharging into the local water bodies

Finally, it is recommended that the concerned authority should come forward to establish a common ETP to minimize the negative impact of hazardous substances released directly from different industrial units into environment as a form of effluents. It is also essential to create awareness among the people about the consequences of environmental degradation caused by industrial effluents. The importance of safe handling of industrial effluents has gained international attention over the last decade. Under such circumstances, a summary of the possible measures that can be undertaken are as follows,

- Industries should establish ETP for treating the industrial effluents so that they can be treated before final disposal into the environment.

- Effluent discharging should be properly managed to minimize its effects on the environment and appropriate laws should be strictly implemented.

- Appropriate distance should be maintained between effluent discharge points and surrounding water bodies for maintaining ecological balance.

5. Conflict of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

6. References

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