

Physico Chemical Analysis of Water of Ayad River at Udaipur, Rajasthan (India)

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Abstract: The present study was conducted to evaluate water pollution status of Ayad River after crossing the urban and industrial area of Udaipur. Ayad River is very old River which passes through the heart of Udaipur city, it carries waste water containing urban and industrial effluents. Two sampling stations Domestic effluent station and Industrial effluent station were identified for sampling. The water quality variables were analyzed as per standard methods given in American Public Health Association (APHA, 1989). Water quality parameters such as pH, temperature, conductivity, TDS, DO, BOD₅, COD, TOC, acidity, alkalinity, total hardness, chloride, nitrate, phosphate, MPN, and heavy metals were analyzed and results were compared with the control water sample which was distilled water.

Keywords: Domestic effluent, industrial effluent, distilled water, heavy metal, MPN

I. INTRODUCTION

Water is a most valuable natural resource for all living creatures on the earth, essential for the sustenance of life as exemplified by its diversified uses (drinking, cooking, washing, irrigation, farming, industrial activities etc). Water may be contaminated by various means, chemically or biologically and may become unfit for drinking and other uses. 70% of the water is seriously polluted in our country. Water pollution is primarily associated with domestic and industrial waste. In developing countries, industrial effluents and domestic sewage are indiscriminately discharged into adjoining rivers and water bodies without any pre treatment. Domestic waste water contains a large amount of organic matter, nitrate, phosphate, chloride, detergents, inorganic salt, oil etc. Industrial effluents contain a variety of pollutants such as heavy metals, pesticides, fertilizers, detergents, organic and inorganic salts, oil, coliforms etc. which create serious problems to the non target organisms.

Today, due to various anthropogenic activities, the river water usually receives untreated sewage, domestic waste, industrial and agricultural effluents that results in pollution of several rivers in India and abroad. During the last several decades the water quality of the Indian river has been deteriorating due to continuous discharge of industrial waste and domestic sewage ([1], [2] and [3]). Industries are dumping their effluents into the rivers, thereby polluting them severely ([4] and [5]). Due to high organic loads and toxic materials, the industrial effluents from industries are a major source of water pollution in Indian rivers. Water pollution is primarily associated with domestic and industrial waste. Waste water discharge from sewage and industries are major component of water pollution contributing oxygen demand and nutrient loading of the water bodies, promoting toxic algal blooms and leading to a destabilized aquatic ecosystem ([6] and [7]). Assessments of river water quality have been done by various investigators in India ([8], [9], [10], [11] and [12]).

Udaipur is the lake city; there are many lakes, rivers and water bodies. The Ayad River is main river of Udaipur city which is passing through the heart of Udaipur city. It is one of the oldest river in the history of Mewar which has been long quenching the people of Udaipur city. But due to continuous anthropogenic interference or rather exploitation, today it is much polluted. It carries all domestic waste water from urban housing and settlement and industrial waste water from industrial pockets of Udaipur. All the domestic waste water and industrial waste water finally terminates into Udai Sagar Lake.

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II. MATERIALS AND METHODS

For the study, two sampling stations on Ayad River were identified for collection of sample water. In which, one sampling station for Domestic Effluent and another for Industrial Effluent.

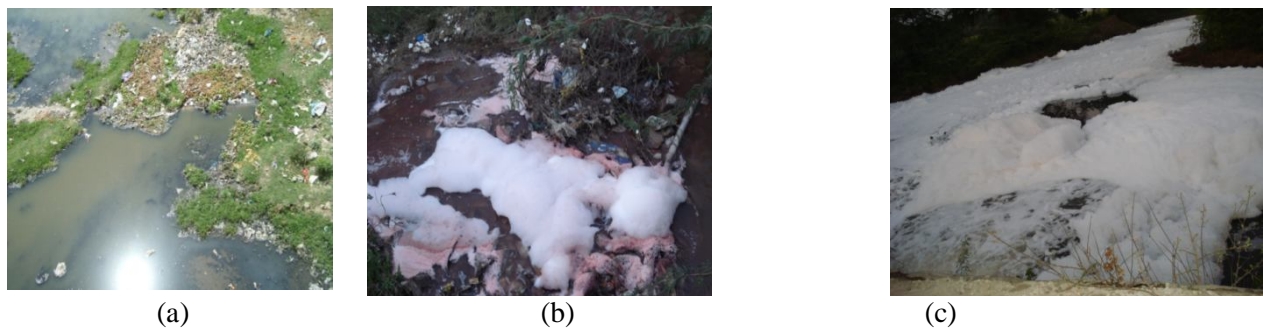


Fig.1: (a) Photograph of Domestic Effluent Sampling Station, (b) Photograph of Industrial Effluent Sampling Station, (c) Photograph showing pollution status of Ayad River after crossing Industrial Area.

Distilled water was used as a Control Sample. The water quality variables were analyzed as per standard methods supported by ([13], [14], [15], [16] and [17]). For analysis of each sample three replicates were used. For statistical analysis of the results One way ANOVA was conducted.

III. RESULTS AND DISCUSSION

In the Control sample, distilled water was used so it showed slightly basic nature. Generally, natural water is slightly alkaline due to presence of carbonates and bicarbonates. Domestic Effluent was basic in nature because it contains many ions of salt like sulphates, carbonates, bicarbonates, chlorides, sodium, fluoride, etc. which was mainly from urban area where many domestic activities were adding to the pollution load while Industrial Effluent was acidic in nature. Acidic pH of effluent may be attributed to discharge of Sodium Silico Fluoride (SSF) Units and other small scale industries. In Sodium Silico Fluoride (SSF) Units hydro chloric acid (HCL) is generated during production of crystals of sodium silico fluoride.

Sr. No.	Parameters	Unit	Discharge limit of effluents into public sewers. Indian Standards: 3306 (1974)	Control Sample	Domestic Effluent	Industrial Effluent
				Range	Range	Range
1.	Colour		-	Colourless	Dark Brown	Brown
2.	Odour		-	Odourless	Unpleasant	Unpleasant
3.	pH		5.5 – 9.0	7.7 - 7.9	7.4 -7.7	5.5 -5.7
4.	Conductivity	mS/cm	-	BDL	0.40 - 0.61	0.82 - 2.04
5.	Total Dissolved Solids (TDS)	ppm	2100	BDL	650 - 1026	1208 - 3000
6.	Dissolved Oxygen	ppm	-	BDL	0.15 - 0.46	0.0 - 0.7
7.	BOD ₅	ppm	350	BDL	60.5 - 92	85 - 102
8.	COD	ppm	-	BDL	178 - 203	169 - 203
9.	Alkalinity	ppm	-	BDL	360 - 390	588 - 630
10.	Total Hardness (As CaCO ₃)	ppm	-	BDL	580 - 915	1100 - 2420

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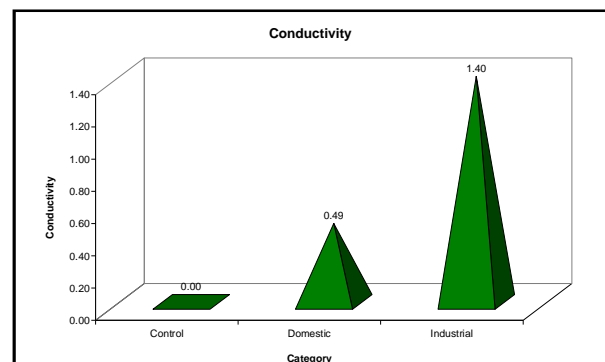
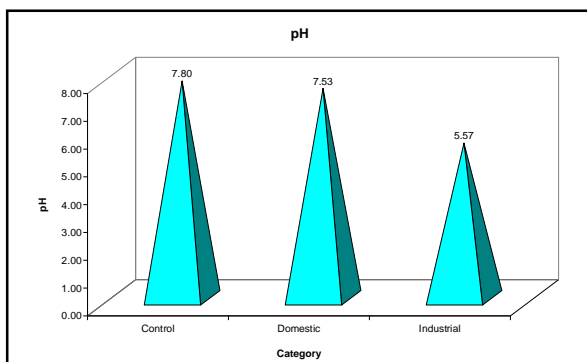
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11.	Sulphate (As SO ₄)	ppm	1000	BDL	78.4 - 90.7	300 - 420
12.	Chloride (As Cl ⁻)	ppm	1000	BDL	510 - 830	822 - 2034
13.	Fluoride (F ⁻)	ppm	15	BDL	7.6 - 9.5	29.7 - 37.6
14.	Silica (As SiO ₂)	ppm	-	BDL	40 - 60	60 - 80
15.	Sodium	ppm	60	BDL	24.5- 205	150- 545
16.	Total Organic Carbon (TOC)	ppm	-	BDL	13 - 16	7 - 12
17.	Nitrate (As NO ₃)	ppm	-	BDL	11.0 - 12.2	7.2- 9.0
18.	Phosphate (As PO ₄)	ppm	-	BDL	35 - 40	75 - 98
19.	MPN	Nos/ 100ml	-	BDL	240 - 918	26 - 43
20.	Zinc (As Zn)	ppm	15	BDL	0.21 - 0.30	2.66 - 3.94
21.	Cadmium (As Cd)	ppm	01	BDL	BDL	BDL
22.	Copper (As Cu)	ppm	03	BDL	BDL	0.5 - 0.6
23.	Lead (As Pb)	ppm	01	BDL	BDL	BDL

BDL = Below Detection Limit

Table-1: Physico chemical analysis of effluents

Highest EC was recorded in the Industrial Effluent because it contained many chemicals, salts and dissolved solids [18]. Higher EC indicates the presence of high amount of dissolved inorganic substances in ionized form [19]. Domestic Effluent also showed moderate to high value of EC. Electrical Conductance in Control water was found below detection limit because it is distilled water and in distilled water presence of ions and chemicals is in minute quantity so; EC is found below the detection limit.



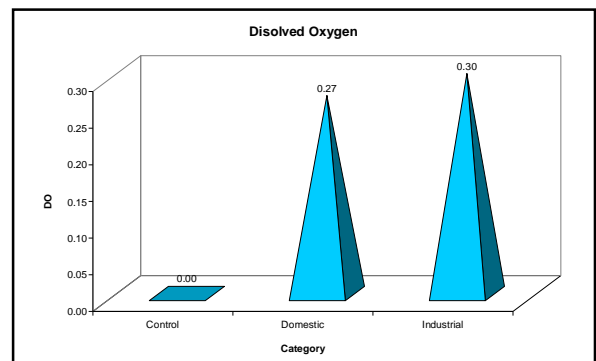
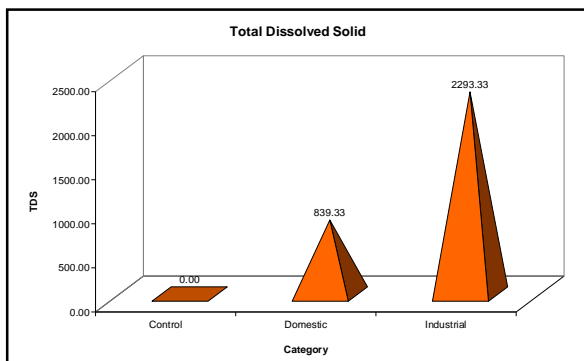
Higher value of TDS exhibit in Domestic and Industrial Effluent which may be because both effluents was polluted and they carried inorganic salt, carbonate, bicarbonate, chloride, organic matter, nitrate, phosphate, fluoride, sodium, silica etc. Domestic and Industrial Effluent carried a large amount of ions of many chemicals, inorganic salts, heavy metals, oil and grease etc. showed higher TDS value. In Control Sample, TDS level was found below detection limit because it is distilled water in which, presence of ions and chemicals in minute quantity, so TDS value was found below the detection limit. Increased total dissolved solids (TDS) and biological oxygen demand (BOD) may suggest increased organic matter (OM) within the stream from industrial discharge, wastewater and effluents and ability of self-purification ([20], [21] and [22]). Domestic and Industrial Effluent recorded very low DO, because both carried

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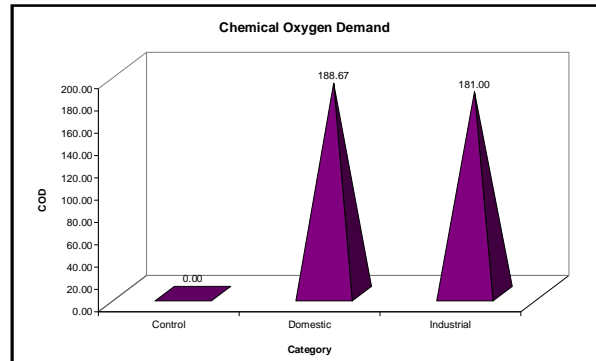
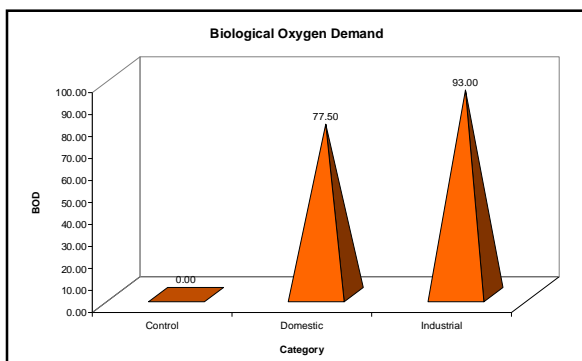
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inorganic and organic matter and in decomposition of organic matter DO was consumed by micro organisms. So Domestic and Industrial Effluent collected from these stations have very low DO value but BOD and COD values have not reduced, as chemical oxygen demand and biological oxygen demand require time for their reactions to be complete. Minimum level of DO was due to chemical impurities, stagnant condition and microbiological growth in water [23].



In the conducted experiments, BOD₅ was high in Domestic and Industrial Effluent due to high organic load and excessive growth of total micro organisms [24]. This may be as a result of escape of organic matter (organic) into the river mostly from faecal waste deposition by the surrounding urban area and human settlements. Control Sample revealed BOD₅ value below detection limit, because it was distilled water and had no organic load. Highest COD values were found in Domestic Effluent which may be due to the incessant inflow of sewages from urban areas [25].

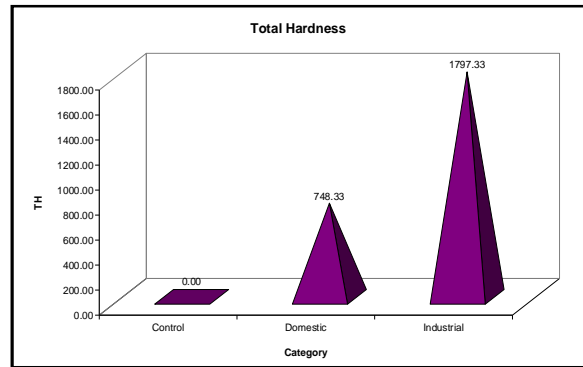
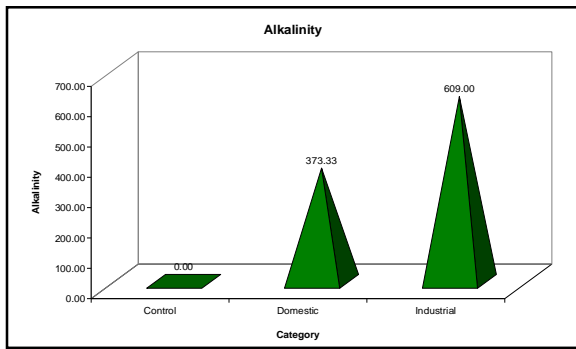


The alkalinity values were found to be much higher than BOD values in both Domestic and Industrial Effluent, indicating presence of considerable amount of chemically oxidizable matter, most of which were non biodegradable. The value of total hardness was high in Industrial Effluent and Domestic Effluent because hardness is mainly due to cations of calcium, magnesium and anions of carbonate, bicarbonate and sulphate, chloride, fluoride etc. [26]. Hardness is also closely related to alkalinity. Control Sample exhibited BDL value of hardness because distilled water was used as Control and it is completely uncontaminated.

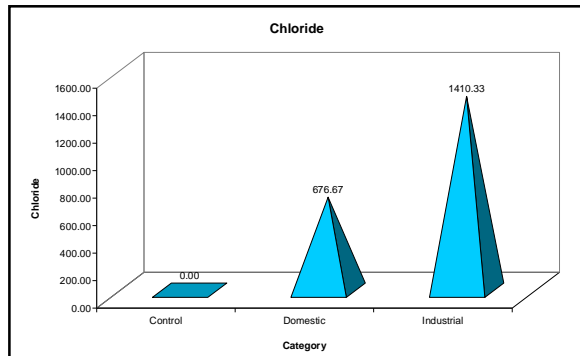
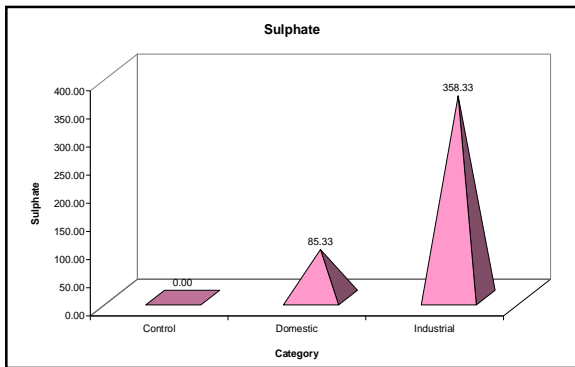
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The sulphate concentrations were high in Domestic and Industrial Effluent which attributes to large amount of discharge of sewage and chemicals from the urban area and industrial units [19]. In Industrial area there are some industries which discharge acidic water which may be another cause of high level of sulphate in Industrial Effluent. Discharge of industrial wastes and domestic sewage tends to increase its concentration. Sulphates may also come from a large influx of industrial wastes such as tanneries, paper, textiles *etc.* High level of chlorides may be consequence of heavy sewage influx and domestic effluent dumping in water bodies [23]. The most important source of chlorides in the waters is the discharge of domestic sewage [27]. In Industrial Effluent high level of chloride may be due to discharge of Sodium Silico Fluoride Units, which contain HCL in effluent. Due to presence of HCL in effluent, chloride level was found to be high in Industrial Effluent.

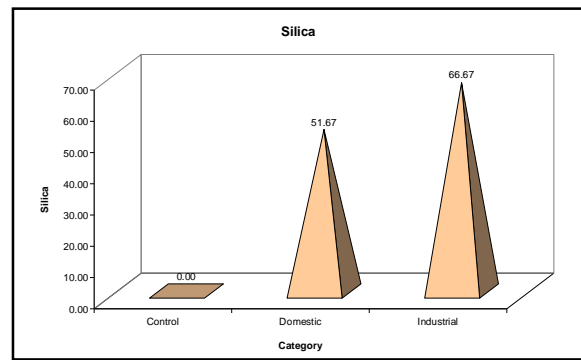
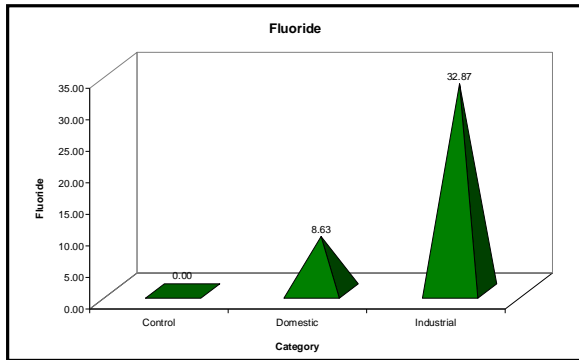


In the Domestic Effluent the main source of fluoride was toothpaste, food stuff and detergents which were used in houses for domestic activities which may be possible reason for moderate high level of fluoride in Domestic Effluent. In the Industrial Effluent the main source of fluoride may be discharge of Sodium Silico Fluoride (SSF) Units. Thus fluoride values could be very high in Industrial Effluent. According to reference [28] and [29], the weathering of fluorine bearing minerals such as flourspar, granite, gneisses and crystalline rocks containing biotite, muscovite, apatite, cryolite, tourmaline spene and hornblende minerals releases fluoride. In the Domestic Effluent, kitchen waste and domestic activities like washing, cleaning is the main source of silica while in the Industrial effluent the main source of silica may be discharge of Sodium Silico Fluoride (SSF) Units and other small scale industries.

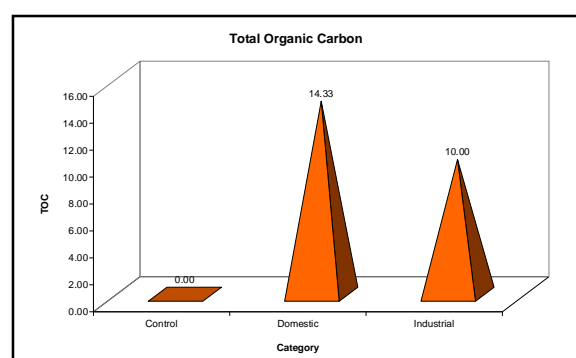
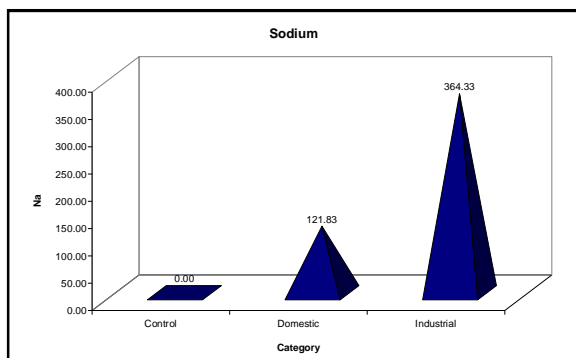
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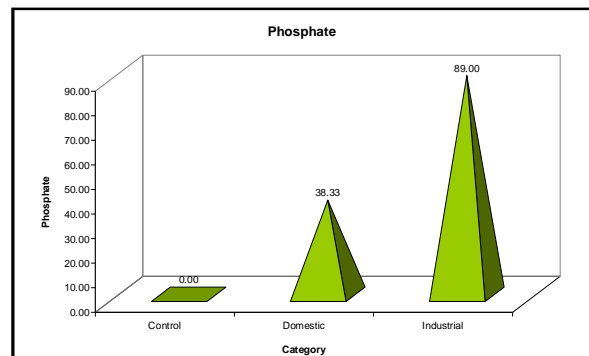
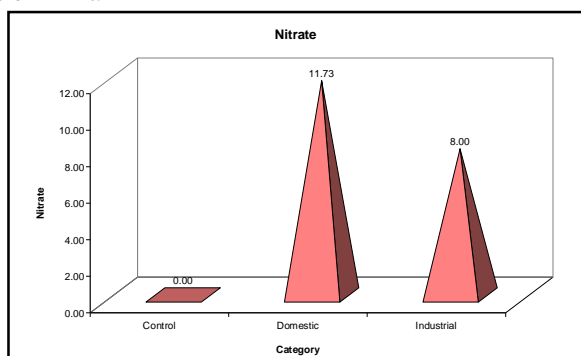
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Sodium was very high in Domestic and Industrial Effluents. TOC value was found higher in Domestic Effluent because it contains organic contents, faeces, bio degradable and non biodegradable chemicals from various domestic activities. Control Sample was found below detection limit of TOC because distilled water was totally pure and had no organic load.



The total nitrate content recorded was very high during the present analysis. The nitrate values, between 11.0 to 12.2 ppm and also between 7.2 to 9.0 ppm in Domestic and Industrial Effluent respectively as compared to the Control Sample where the nitrate concentration was found to be below the detection limit. The phosphate content also recorded to be very high in both the samples. The phosphate content observed were in Domestic Effluent and Industrial Effluent with a range of 35 to 40 ppm and 75 to 98 ppm respectively. In Control Sample, phosphate was found to be below detection limit.

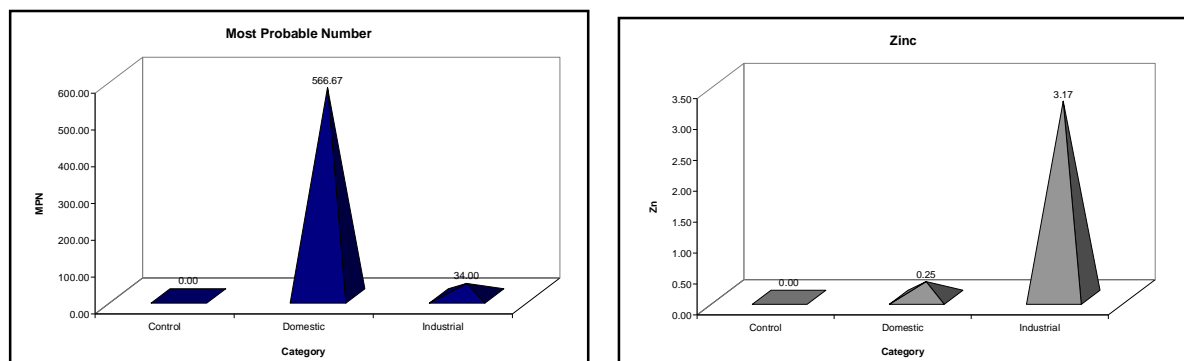


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The fairly high values of faecal coliforms in Domestic Effluent are indicative of increasing pollution of the river by organic means particularly through the discharge of sewage and domestic effluents into the river. The faecal coliforms were found maximum in Domestic Effluent which is due to discharge of excreta from human beings and other homeotherms. Therefore a potential health risk exists due to presence of microbial pathogens in water.



In the present investigation the zinc content was high in Industrial Effluent falling in the range of 2.66 ppm to 3.94 ppm and in Domestic Effluent falling in the range of 0.21 to 0.30 ppm. The copper content was observed only in Industrial Effluent (ranging from 0.05 ppm to 0.06 ppm). At other stations the copper content was below detectable limit. Cadmium and Lead in all samples were found below detectable limit.

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