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Original Research Paper

A Study on the Coliform Bacterial Density and Heavy Metal Concentration of Tumkur City Sewage

K. S. Kumara and S. L. Belagali*
Department of Chemistry, Sri Siddhartha First Grade College, Maralur, Tumkur-572105, Karnataka
*Department of Studies in Environmental Science, University of Mysore, Mysore-570 006, Karnataka

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ABSTRACT

The Tumkur city sewage samples were analysed between February 2007 and January 2008 at six sampling points symbolised as residential area (S_1), business centre (S_2), slum (S_3), converging point (S_4), open drain (S_5) and treated sewage (S_6) to assess the bacterial density and concentration of some heavy metals. The results revealed the presence of maximum bacterial population in June, and minimum in January. Systematic sampling and quantitative analysis of heavy metals such as copper, lead, zinc, nickel, cadmium, chromium, manganese and Iron have been carried out and an attempt was made to correlate heavy metal concentration to bacterial population in sewage. The bacterial population declined notably in treated sewage.

INTRODUCTION

Sewage is the domestic waste generated by industries, garden runoff, laboratories, hospitals, bathrooms, toilet wastes, etc. It is enriched with nutrients, pathogenic microorganisms and plays a vital role in causing water pollution. Greater urbanization, industrialization and rapidly increasing population over the last few decades are responsible for the production of huge quantities of wastewater, often disposed off into the environment without any treatment (Chafai Azri et al. 2007). The impact of the waste components in altering habitat integrity of natural water bodies has been reported (Ajayi & Osibanjo 1981, Ibiebele et al. 1987, Chindah et al. 2005).

The microbial contamination, particularly by pathogenic microorganisms, is the most important factor in causing water pollution. Contamination of water is a serious environmental problem, as it adversely affects the human health and biodiversity in aquatic ecosystems. Enteric pathogens are typically responsible for waterborne sickness (Karaboze et al. 2003). Pathogens are a serious concern for managing water resources, as the excessive amounts of faecal bacteria in sewage and urban runoff are known inducers of diseases like cholera, typhoid, diarrhoea, etc. in human beings (Fleisher et al. 1998). In developing nations, the challenges of handling and treating wastewaters have been difficult due to the unaffordable financial implication for government. It is for this reason that research efforts were being made to identify an inexpensive but effective procedure in improving the quality of wastewater (Chindah et al. 2005).

Attention has also been focused on heavy metals as environmental pollutants since the occurrence of "Itai-Itai" disease caused by cadmium poisoning and Minamata disease caused by methyl mercury poisoning are well known. Measuring the heavy metal concentrations in aquatic environments is an important tool to assess and monitor degree of pollution of aquatic systems (Kumar &

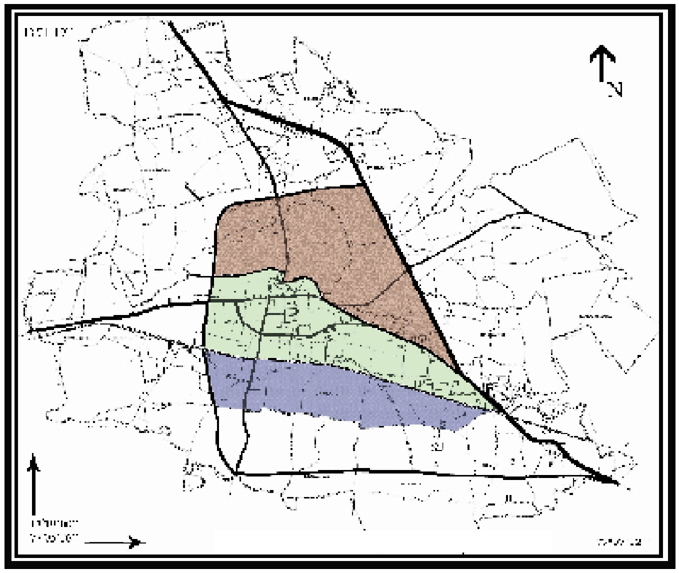

Fig. 1: Tumkur city map showing sewage sampling points.

Mahadevan 1995). In aquatic environment metals can be termed as conservative pollutants and persist forever without being broken down to harmless products (Sengupta & Kureisly 1989). Heavy metals are also known to be the potent inhibitors of ATPase (Haya & Waidood 1983). Jakim (1974) made extensive studies on the sensitivity of cell-enzymes to heavy metals in animal tissues.

Information on the distribution of heavy metals in untreated and treated wastewater is essential to assess the accumulation levels in organisms and their possible transfer to food chain, which governs the fishery potential. Considering the above aspects, a study was conducted to investigate the density of coliform bacteria, heavy metal concentration and their relationship in the sewage of Tumkur city.

MATERIALS AND METHODS

Tumkur city is situated between 13° 19' 00" to 13°21'19" N latitude and 77°05'26" to 77°07'12"E longitude at 818.51m on MSL and 68 km northwest of Bangalore city. The 70 % of city area is covered by underground drainage (UGD) facility. The sewage samples were collected in sterilized bottles for bacterial analysis from six sampling points namely S_1, S_2, S_3 (closed), S_4 (converging), S_5 (open) and S_6 (treated) (Fig. 1) during 7 a.m. to 8 a.m. on first week of every month and immediately brought to the laboratory for analysis. The bacterial colonies were allowed to develop on Flexi plate (Hi-Media) at 37°C in incubating chamber for 24 hours following the standard methods outlined in APHA (1995) (Fig. 2). The bacterial colony counts were made by using Seagul counting cell. Simultaneously sewage samples were collected in polythene bottles and preserved with concentrated nitric acid for the determination of heavy metals using atomic absorption

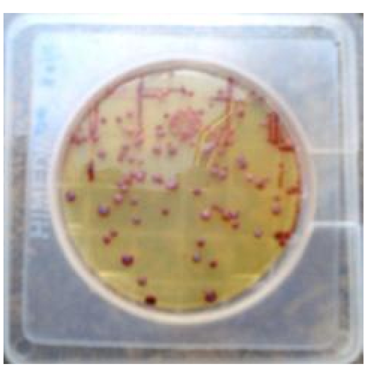

Fig 2: Bacterial colonies developed on Hi-Media flexi plate.

spectrophotometer following APHA (1995) and Trivedy & Goel (1986). The correlation coefficient 'r' was calculated using MS Office 2007 Windows EXCEL statistical package.

RESULTS AND DISCUSSION

The results of the study on analysis of coliforms and heavy metals in sewage are given in Table 1. The higher values of bacterial count were observed in the month of June for all the samples (Fig. 3), which is in accordance with the observation of Kataria et al. (1997). The maximum number in the month of June is due to higher bacterial activity at higher temperature. The minimum bacterial counts were observed in rainy season for S_1 and S_3 sites and in winter for the remaining samples. The minimum value in S_1 and S_3 sites is due to dilution of sewage by rain water influx and low temperature, whereas in other samples, due to low temperature only.

The bacterial population was observed low for open drain (S_5) and very low for treated sample (S_6). The low bacterial population in open drain may be due to less influx of faecal waste. The very low values of bacterial population in treated sample (S_6) are due to aeration treatment and low nutrient values. However, this population is sufficient to cause bacterial pollution.

Copper is an essential metal required by all living organisms for enzyme activity, but at higher concentration it is a pollutant. In sewage samples, concentration of copper varied from below detectable level to 0.25 mg/L (S_4 in May 2007). The copper content in city sewage is within the standards indicating negligible pollution by industries.

The maximum concentration of lead was 0.18 mg/L. Lead is toxic metal and its concentration in sewage is mainly through pesticide and paint runoff. Higher concentration of lead causes disruption of various physiological activities of organisms (Panda & Sahu 2002). However, in most of the samples lead concentration was found to be below the maximum permissible limit set by WHO (1984).

Pollution from industrial and agricultural sources to a great extent is responsible for high concentration of zinc in water. The zinc concentration in sewage is below the standards (5 to 15 mg/L, ISI 1983). The values range from 0.1 to 3.32 mg/L, which do not alter the quality of sewage.

The highest concentration of nickel, cadmium and chromium were found to be 0.06, 0.01 and 0.04 mg/L respectively and not detected in all the samples. The recommended maximum concentration of nickel in irrigation water (Kannan 1991) has been fixed to be 0.20 mg/L. Hence, treated sewage water can be used for irrigation. Since, the concentrations of these metals are very less, the possible bioaccumulation will also be very less.

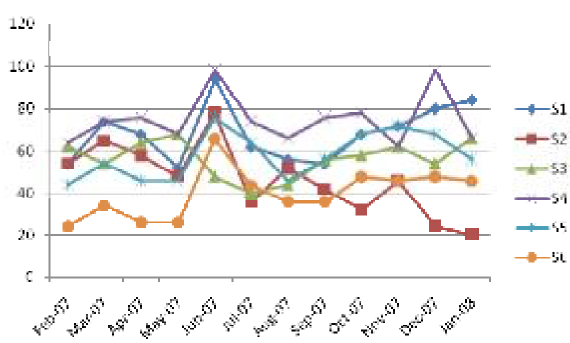

Fig. 2: Variations of total bacterial count at different sampling stations.

The presence of manganese and iron was observed in all the samples. The concentration of manganese varied from 0.01 to 0.53 mg/L, and of iron from 0.40 to 2.00 mg/L. The higher concentration of these metals was attributed to the presence of engineering industries in the city limits.

The correlation coefficient 'r' calcu-

Table 1: Variations in heavy metal concentration and bacterial population in sewage.

	Copper	Lead	Zinc	Nickel	Cadmium	Chromium	Manganese	Iron	TC×10^6
Sample Station 1									
Feb-07	0.22	0.12	0.54	ND	ND	ND	0.24	1.62	54
Mar-07	0.22	0.18	0.53	ND	ND	ND	0.24	1.72	74
Apr-07	0.02	ND	0.85	ND	ND	ND	0.25	0.78	68
May-07	0.13	0.12	0.58	0.04	0.01	0.10	0.28	0.06	52
Jun-07	0.02	0.10	0.12	0.02	0.01	ND	0.04	0.80	94
Jul-07	ND	0.02	0.48	0.04	0.01	ND	0.04	0.83	62
Aug-07	0.02	0.01	0.30	0.01	0.01	ND	0.04	0.82	56
Sep-07	ND	ND	0.29	0.06	0.01	ND	0.03	0.60	54
Oct-07	0.02	0.01	0.54	0.02	0.01	ND	0.02	0.80	68
Nov-07	0.02	0.18	0.48	0.04	0.01	0.02	0.03	0.60	72
Dec-07	0.02	0.12	0.12	0.01	0.01	ND	0.02	0.82	80
Jan-08	0.01	0.02	0.46	0.06	0.01	0.02	0.04	0.60	84
Sample Station 2									
Feb-07	0.14	0.18	0.88	ND	ND	ND	0.12	1.40	54
Mar-07	0.14	0.15	0.95	ND	ND	ND	0.01	1.45	65
Apr-07	ND	ND	ND	ND	ND	ND	0.02	0.41	58
May-07	0.03	0.05	0.63	0.01	0.01	0.04	0.53	0.80	48
Jun-07	0.06	0.08	2.44	0.02	0.01	0.02	0.17	0.9	78
Jul-07	ND	ND	0.25	0.02	0.01	ND	0.18	0.53	36
Aug-07	ND	ND	0.23	0.01	0.01	ND	0.18	0.57	52
Sep-07	ND	ND	0.31	0.03	0.01	ND	0.16	0.56	42
Oct-07	ND	0.04	0.88	0.02	0.01	0.02	0.20	0.60	32
Nov-07	0.04	0.15	0.82	0.02	ND	0.01	0.17	0.58	46
Dec-07	0.05	0.06	0.24	0.01	0.01	0.02	0.20	0.57	24
Jan-08	0.02	ND	0.26	0.02	ND	0.01	0.18	0.56	20
Sample Station 3									
Feb-07	0.12	0.14	1.22	ND	ND	ND	ND	1.22	62
Mar-07	0.12	0.14	1.47	ND	ND	ND	ND	1.58	54
Apr-07	ND	ND	0.25	ND	ND	ND	ND	0.74	64
May-07	0.07	0.06	0.40	0.04	ND	0.04	0.24	0.40	68
Jun-07	0.01	0.01	0.22	0.02	0.01	ND	0.19	0.80	48
Jul-07	ND	ND	0.27	0.04	0.01	ND	0.20	0.61	40
Aug-07	ND	ND	0.32	0.03	0.01	ND	0.18	0.50	44
Sep-07	ND	ND	0.37	0.06	0.01	ND	0.20	0.66	56
Oct-07	ND	0.01	0.92	0.02	ND	ND	0.30	0.84	58
Nov-07	0.01	0.14	0.94	0.02	0.01	ND	0.20	0.54	62
Dec-07	0.02	0.06	0.16	0.02	ND	ND	0.30	0.86	54
Jan-08	0.01	0.02	0.10	0.04	0.01	ND	0.22	0.58	66
Sample Station 4									
Feb-07	0.13	0.18	0.62	ND	ND	ND	0.04	1.28	64
Mar-07	0.13	0.18	0.53	ND	ND	ND	0.04	1.29	74
Apr-07	ND	ND	0.44	ND	ND	ND	0.06	0.44	76
May-07	0.25	0.16	3.32	0.04	0.01	0.01	0.11	2.0	68
Jun-07	0.01	0.06	0.20	0.02	0.01	0.01	0.19	1.7	98
Jul-07	ND	0.01	0.61	0.05	0.01	ND	0.21	1.05	74
Aug-07	ND	ND	0.16	0.01	0.01	ND	0.18	0.70	66
Sep-07	ND	ND	0.24	0.03	0.01	ND	0.18	0.59	76
Oct-07	ND	ND	1.20	0.02	0.01	ND	0.19	0.54	78

Table cont...

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Nov-07	0.01	0.15	0.94	0.04	0.01	ND	0.18	0.68	62
Dec-07	0.02	0.02	0.24	0.03	0.01	ND	0.10	0.50	98
Jan-08	0.02	0.04	0.26	0.04	0.01	ND	0.18	0.68	66
Sample Station 5									
Feb-07	0.10	0.15	0.96	ND	ND	ND	0.10	0.86	44
Mar-07	0.10	0.15	0.95	ND	ND	ND	0.10	0.95	54
Apr-07	0.13	ND	0.48	ND	ND	ND	0.02	0.42	46
May-07	0.03	0.02	0.53	0.01	ND	0.02	0.07	2.0	46
Jun-07	0.02	0.04	0.14	0.02	0.01	ND	0.30	1.2	76
Jul-07	ND	ND	0.10	0.04	0.01	ND	0.29	1.19	64
Aug-07	ND	ND	0.42	0.01	0.01	ND	0.31	0.86	46
Sep-07	ND	ND	0.20	0.05	0.01	ND	0.19	0.57	56
Oct-07	ND	ND	0.54	0.02	0.01	0.01	0.18	0.80	68
Nov-07	ND	0.16	0.56	0.02	ND	ND	0.03	0.60	72
Dec-07	0.01	0.04	0.20	0.01	0.01	0.01	0.18	0.70	68
Jan-08	0.02	0.02	0.62	0.04	ND	ND	0.03	0.60	56
Sample Station 6									
Feb-07	0.02	0.07	0.50	ND	ND	ND	0.09	0.92	24
Mar-07	0.02	0.12	0.50	ND	ND	ND	0.02	0.92	34
Apr-07	ND	ND	0.44	ND	ND	ND	0.08	0.44	26
May-07	0.02	0.12	0.50	0.04	0.01	ND	0.09	0.92	26
Jun-07	0.03	0.07	0.35	0.02	ND	ND	0.04	0.5	66
Jul-07	ND	ND	0.22	0.01	0.01	ND	0.05	0.41	44
Aug-07	ND	ND	0.28	0.02	0.01	ND	0.03	0.06	36
Sep-07	ND	ND	0.39	0.04	0.01	ND	0.03	0.90	36
Oct-07	ND	ND	0.56	0.02	0.01	ND	0.02	0.04	48
Nov-07	0.01	0.18	0.58	0.01	0.01	ND	0.18	0.90	46
Dec-07	0.02	0.06	0.30	0.02	0.01	ND	0.02	0.06	48
Jan-08	0.01	ND	0.22	0.02	0.01	0.01	0.18	0.80	46

Note: All metals are expressed in mg/L.

Table 2: Correlation coefficient (r) of various heavy metals with total coliform bacteria.

	S_1	S_2	S_3	S_4	S_5	S_6
Cu	-0.43	0.51	0.10	-0.38	-0.65	0.25
Pb	0.10	0.40	0.14	-0.55	0.08	-0.15
Zn	-0.37	0.70	0.16	-0.28	0.49	-0.30
Ni	-0.18	0.02	0.09	-0.29	0.02	-0.55
Cd	-	-	-	-	-	-
Cr	-0.92	0.25	-	-	-	-
Mn	-0.35	-0.24	0.34	0.05	0.30	-0.05
Fe	0.06	0.50	-0.04	0.02	-0.10	-0.35

lated between heavy metals and bacterial density was found to be negative for many metals but not much significant (Table 2). Hence, the present study revealed that the concentration of heavy metals in sewage is less and their relation with bacterial population is insignificant. The bacterial populations of sewage samples were rather dependent on presence of organic matter in sewage.

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