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ASSESSMENT OF THE QUALITY OF SEWAGE EFFLUENT AROUND CUTTACK TOWN OF ODISHA

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The physico-chemical properties of domestic sewage effluents disposed off in the canal around Cuttack district of Orissa were studied. The results indicated that the salt load (electrical conductivity) was in between 1030 and 2810 μScm^{-1} Sewage effluents also showed the higher BOD above the BIS standard. Total viable count, E.coli and Coliform count mL^{-1} were highest in the post monsoon season and rangred from 26000 to 35000 and 42500 to 52600. Such waters are non-potable. Although, the effluents contain heavy metals Pb, Co, Cr and Cd, an appropriate dilution can make them worth using in agricultural fields to minimize its hazardous effect. Cadmium content was found to be above the BIS limits (0.01 mgL^{-1}). Long-term application of these effluents may increase concentration of heavy metals to considerable levels vis-à-vis in the agricultural crops and vegetation.

KEYWORDS : Sewage effluent, BOD, COD. Total viable count, E. Coli and Coliform, Heavy metals.

INTRODUCTION

Due to more urbanization and industrialization, environmental pollution is increasing day by day. The disposal of city waste, sewage water and industrial effluents (herein referred as municipal waste water) is becoming a major problem. Although, application of sewage effluents were reported to be beneficial in increasing crop yield and reduce fertilizer requirement[3] but some other studies showed that metals like Cu, Cd, Cr enter in the food chain through their application in soil and this ultimately causes health concern significantly [9]. Disposal of raw sewage on land or in natural streams causes physical, chemical and biological hazards. The present study was planned to know the seasonal variation in the chemical and microbiological properties of untreated municipal wastewater at different locations of Cuttack Town of Odisha.

MATERIAL AND METHODS

The canal is one of drainage canal which carries city drainage of a metropolitan town Cuttack in which about 165 MLD municipal waste water including sewage is being discharged daily. After traveling a distance of 20 km through Cuttack town it enters Kathjodi River. Several types of industries exist in the nearby city, namely Cuttack and the domestic and industrial waste of these major city are responsible for degrading the quality of river Kathjodi

Municipal wastewater was collected during the year 2015 and 2016 in the pre-monsoon (June) and post-monsoon (December) seasons from 10 sampling sites of the three different locations, Pattapolo, Gamhadia and Chhatra Bazar. The water samples were anlysed for EC, pH, TDS, carbonates, bicarbonates, chloride, sulphase, nitrate, phosphorus, total hardness, turbidity, BOD and COD as per the method outlined by Gupta [4]. Calcium, magnesium, sodium and potassium were determined by the methods suggested by Richards [7]. The samples were analyzed for biological properties as mentioned in APHA (1995). Heavy metals and micronutrients analysis was done with the help of Atomic Absorption Spectrophotometer (Perkin-Elmer 100). The results (mean of 10 samples collected in 1 year from 3 locations for the pre-monsoon (June) and post-monsoon (December) seasons are presented below and discussed in light of the different standards for discharge of waste water/sewage set by IS : 3307-1977.

Results and discussion

The municipal waste water containing sewage and industrial effluent was alkaline in reaction both in pre and post monsoon with pH values ranging between 7.2 – 7.6 (Table 1) and was within the permissible limits of pH for irrigation which vary between 6 to 9 as laid down in IS:3307-1977. Electrical conductivity (EC) values of these effluents ranged from 1030 – 2810 and 1835 – 2648 μScm^{-1} in pre and post monsoon season, respectively at different locations. The sodium adsorption ratio (SAR) varied from 1.20 – 2.85 and 2.35 – 3.50 in pre monsoon and post monsoon sampling respectively and most of these were within the critical limit (3.0) for irrigation purpose (IS : 3307- 1977). The sodium adsorption ratio (SAR) of the municipal wastewater sampled from Pattapolo location is around 1.2 during pre and 2.35 in post monsoon with EC above 1835 μScm^{-1}. Use of such waters for irrigation creates the problem of soil sodicity [8]. Total dissolved solids (TDS) of Chhatrabazar effluent sample in post monsoon season was beyond the maximum recommended limit (*i.e.* 2655 mgL^{-1}) for land irrigation as reported by Juwarkar [6]. Biological oxygen demand (BOD) and chemical oxygen demand (COD) varied from 185 – 710 and 295 – 1250 mgL^{-1} in pre monsoon and 187 – 1020 and 295 – 1230 mgL^{-1} respectively in post monsoon season. Comparatively lower BOD and COD were observed during monsoon due to dilution of the effluent, which is in agreement with the findings of Adhikari and Gupta [1].

The carbonate content in all the effluents was totally absent whereas, bicarbonate ranged from 212 to 557 mgL^{-1} which was marginal in both the seasons. Owing to the higher Ca & Mg concentration and lower alkalinity due to phenolphthalein and methyl orange ($CO_3 + HCO_3$) the residual sodium carbonate hazard was not observed. Chloride concentration was higher during post monsoon (136–601 mgL^{-1}) in comparison to pre-monsoon sampling (196 – 583 mgL^{-1}). Chloride was at toxic level in all the points in post monsoon on the basis of maximum permissible limit for irrigation (IS:3307- 1977). Similarly, sulphate concentration was also much higher than the tolerable limit (10-14 mgL^{-1}) for irrigation purpose (IS: 3307-1977). Adhikari and Gupta [1] also found that the raw sewage in the winter (post monsoon) season as compared to tolerable limit of 45 mgL^{-1}. The phosphorus content in the effluent was also beyond the limits and ranged from 0.6 to 1.9 mgL^{-1}. It is one of the major causes of water deterioration and these sites may face serious water quality problem like depletion of dissolved oxygen and consequently impair water for both human and aquatic use [10]. Higher phosphorus concentration was obtained in post monsoon season at all the locations. Among the cations, the concentration of Ca^{2+} tended to be the highest followed by Na^{+}, K^{+} and Mg^{+} in post monsoon season.

Table I. Quality of sewage water effluent at different locations of Cuttack Town

Parameters	Pattapolo		Gamhadia		Chhatrabazar	
	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon
pH	7.5	7.4	7.6	7.8	7.2	7.3
ECμScm^{-1}	1030	1835	2020	2530	2810	2648
TDS mgL^{-1}	1633	1160	1380	2250	2522	2655
Turbidity NTU	90	88	125	120	140	195
BOD mgL^{-1}	185	187	290	295	710	1020
COD mgL^{-1}	360	295	1150	1200	1250	1230
CO_3 ($CaCO_3$) mgL^{-1}	Nil	Nil	Nil	Nil	Nil	Nil
HCO_3 ($CaCO_3$) mgL^{-1}	250	293	212	281	456	557
Chloride mgL^{-1}	196	136	270	490	583	601
Sulfate mgL^{-1}	68	80	181	201	218	210
Nitrade mgL^{-1}	5	21	45	54	125	132
Phosphate mgL^{-1}	0.6	0.6	0.9	1.2	1.1	1.9
TH($CaCO_3$) mgL^{-1}	280	525	550	2000	220	525
Calcium mgL^{-1}	130	159	165	300	296	360
Magnesium mgL^{-1}	220	224	87	61	87	80
Sodium mgL^{-1}	34	96	102	222	1500	193
Potassium mgL^{-1}	24	60	38	39	45	82
Iron mgL^{-1}	0.12	0.128	0.053	0.120	0.48	0.52
Copper mgL^{-1}	0.024	0.006	0.014	0.008	0.018	0.009
Manganese mgL^{-1}	0.122	0.113	0.012	0.195	0.308	0.121
Zinc mgL^{-1}	0.086	0.016	0.009	0.088	0.015	0.022
Lead mgL^{-1}	0.033	0.033	0.055	0.083	0.256	0.269
Chromium mgL^{-1}	0.016	0.005	0.006	0.060	0.074	0.095
Cobalt mgL^{-1}	0.102	0.085	0.020	0.045	0.029	0.030
Cadmium mgL^{-1}	0.022	0.023	0.020	0.045	0.029	0.030
SAR $(mmolL^{-1})^{1/2}$	1.2	2.35	2.85	2.80	2.20	3.50

Table II. Microbiological properties of sewage effluent collected from different locations.

Location	Total Viable count/ml		E.Coli		Coliform count/ml	
	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon
Pattapolo	8000	115000	900	37000	2900	42500
Gamhadia	9000	125000	1500	26000	3600	47500
Chhatrabazar	11000	147500	2500	35000	4200	52600

Among the micronutrients, Fe and Mn were found to be prominent and varied from 0.12 – 0.52 and 0.122 – 0.308 mgL^{-1} respectively during post monsoon period. Copper and Zn were present in small quantities. Concentration of all these micronutrients are within the permissible limits for surface application.

Heavy metal concentration followed the order. Ph > Co > Cr > Cd. Cadmium ranged from 0.022 – 0.045 mgL^{-1} and was beyond the maximum recommendation limit (0.01 mgL^{-1}) for land application (IS:3307-1977). The content of Cr varied from 0.016-0.095 mgL^{-1} whereas Co ranged from 0.085–0.030 mgL^{-1}.

The upper limit of both the heavy metals (Cr and Co) was beyond the maximum recommended limit of 0.05 mgL^{-1} (IS: 3307-1977 and Juwarkar [6]).

Total viable count, *E-coli* and *Coliform* count ml^{-1} were highest in post monsoon season (Table II). The highest count of these parameters was recorded in the water collected from Chhatra Bazar. The lowest count of *E-coli* was recorded in summer. Similarly, lower count of *Coliform* ml^{-1} was also observed in the in post monsoon.

Conclusion

The study on the quality of municipal wastewater reveals that the salt load (EC) is in between 1030 and 2810 μScm^{-1}. The BOD of all these waters are above the IS standards and causes problem in long run. Due to continuous application of municipal wastewater, the ground water aquifer gets polluted resulting in increase in salt concentration and BOD. Total viable count, *E-coli* and *Coliform* count ml^{-1} were highest in post monsoon session. Such waters are non-potable. Although, the effluents contain heavy metals Ph, Co, Cr and Cd, an appropriate dilution can made them worth using in agricultural fields to minimize its hazardous effect. The long-term application of these effluents may increase concentration of heavy metals to considerable levels that will ultimately enter in the vegetation grown on such soils. Generally, the average application rate of wastewater per unit area is an excess of normally permissible application rates in any properly managed irrigation system. Therefore, sewage effluents, if treated properly to reduce BOD. Salt load and microbiological properties and used judiciously can provide an alternate source of water for irrigation.

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