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Effect of Domestic Wastes on the Biological Properties of Sewage Effluent under Different Discharge Points in Madurai

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Abstract The capacity of the Sakkimangalam and Avaniyapuram treatment plants were 45.0 MLD and 125 MLD and located in North and South zones of Madurai corporation, Tamil Nadu, India respectively. Around 11 number of discharge points were selected (6 from north and 5 from south zone) and the sewage effluent samples were collected and analyzed for the biological properties viz., DO, BOD, COD and total coliforms content in the sewage samples. The raw sewage samples were collected from 11 discharge points during South West and North East Monsoon, winter and summer seasons from sampling sites for comparison during the year of 2016. The DO content recorded nil in the north zone and 0.0 to 3.8 mgL^{-1} in the south zone but both the values are not good for the living organisms. The high ranges of BOD and COD were observed in all the seasons and zones. The BOD ranged from 200 to 395 mgL^{-1} and COD ranged from 310 to 504 mgL^{-1} in the 11 discharge points and both the parameters are recorded high during summer and low during NEM. The total coliforms content ranged from 2.00 to > 2400 MPN / 100 ml and it was recorded high at South zone and during NEM.

Keywords Sewage effluent, DO, BOD, COD, Total coliforms.

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Introduction

Sewage is a liquid flowing through pipe or channels after it has been spent by a community. It contains the wastes resulting from the use of water for domestic, commercial and industrial purposes either from ground or surface source. Domestic sewage comprises spent water from kitchen, bathroom, lavatory. The factors which contribute to variations in characteristics of the domestic sewage are daily per capita use of water, quality of water supply and the type, condition and extent of sewerage system and habits of the people. Municipal sewage, which contains both domestic and industrial waste water, may differ from place to place depending upon the type of industries and industrial establishment. The sewage water generated in India contains more than 90% water. The solid portion contains 40–50% organics, 30–40% inert materials, bio resistant organics (10–15%) and 5–8% miscellaneous substances on oven dry weight basis (Antil and Narwal 2008). The dissolved oxygen content in water reflects the physical and biological processes prevailing in water and is influenced by aquatic vegetation. Low oxygen content in water is usually associated with organic pollution. If the

Table 1. Dissolved oxygen (DO) of raw sewage water samples (5 mgL^{-1}).

Sl. No.	Collection points	South West Monsoon (Jun-Sep)	North East Monsoon (Oct-Dec)	Winter (Jan-Feb)	Summer (Mar-May)
North zone					
1.	K. K. Nagar	0	0	0	0
2.	Anna Nagar	0	0	0	0
3.	Anna Nagar Uzhavar Sandhai-New	0	0	0	0
4.	Mundirithoppu	0	0	0	0
5.	Thathaneri	0	0	0	0
6.	Vilangudi	0	0	0	0
South zone					
7.	Anuppanadi channel	1.4	1.8	1.2	0.8
8.	Panaiyur channel	1.5	2.4	1.3	1.0
9.	Santhaipettai	0.5	0.9	0.0	0.0
10.	Chottathatti channel	2.1	3.8	1.6	1.4
11.	Chinthamani channel at Arapalayam	0.8	1.2	0.5	0.0
Range					
Minimum		0.0	0.0	0.0	0.0
Maximum		2.1	3.8	1.6	1.4
Mean		0.5	1.0	0.4	0.3
Standard deviation		0.7	1.2	0.6	0.5

dissolved oxygen is more than 5 mgL^{-1}, it can be used for the survival of the microbial populations. The effect of dissolve oxygen content was reflected on BOD of water samples. The BOD of the sewage is the amount of oxygen required for the biochemical decomposition of biodegradable organic matter under aerobic conditions. The oxygen consumed in the process is related to the amount of decomposable organic matter. The COD gives the measure of the oxygen required for chemical oxidation. It does not differentiate between biological oxidisable and non-oxidisable material. The COD values of sewage water were quite above the ISI standard limit of 500 mgL^{-1}. The total coliforms decides the water contamination level in the sewage with a critical point < 2 MPN per 100 ml. The capacity of the Sakkimangalam and Avaniyapuram treatment plants were 45.0 MLD and 125 MLD and located in north and south zones of Madurai corporation, Tamil Nadu, India respectively. The characteristic of the waste water differs from industry to industry and from city to city for domestic waste water, depending upon the standard of living of the people and commercial and industrial activities in the city. Hence the present project was formulated to find out the DO, BOD, COD and total coliforms of the sewage effluent at 11 discharge points of south and north zone of Madurai.

Materials and Methods

The sewage water samples were collected from the 11 different discharge points in Madurai Municipal Corporation, Tamil Nadu in all the 4 seasons viz., South West Monsoon (SWM), North East Monsoon (NEM), winter and summer seasons during 2015-2016. These raw sewage water samples were tested for the DO, BOD, COD and total coliforms as per the standard methods for water and waste water analysis (APHA 1998). The sewage water samples were collected in mouthed, clean, acid washed plastic cans, rinsed with distilled water of 2 liter capacity. For the DO and COD determination, sample has been collected in the clean BOD bottles of 300 mL capacity and the analysis carried out on the same day within

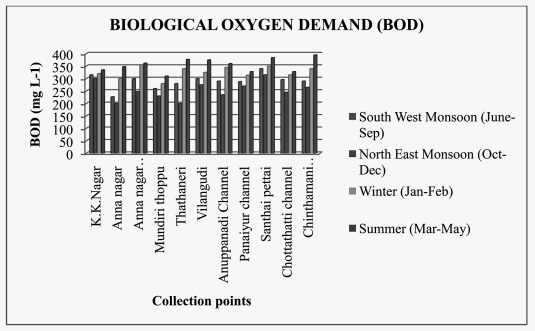

Fig. 1. Biological oxygen demand (BOD) of raw sewage water samples (mg L^{-1}).

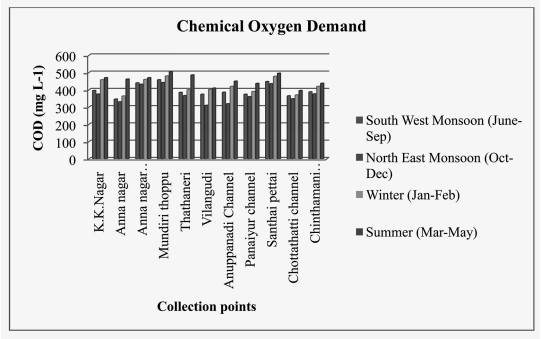

Fig. 2. Chemical oxygen demand (COD) of raw sewage water samples (mg L^{-1}).

1-2 h of sampling and further analysis for BOD has been done in the laboratory after 5 days (20°C). The total coliforms were estimated by lactose broth and completed within 2 days. All the parameters including DO was estimated in accordance with the procedure described in the standard methods for the examination of sewage and industrial wastes. The resultant data were analyzed statistically with minimum, maximum, mean and standard deviation.

Results and Discussion

Dissolved oxygen (DO) of sewage effluent samples (Table 1)

Dissolved oxygen is the one of the important parameters to indicate the quality of water and the microbial activity in water. In north zone of Madurai Municipal Corporation, the dissolved oxygen level was zero. In south zone of Madurai Municipal Corporation (MMC), the lowest value (0.0 mg L^{-1}) of Santhaipettai and Chinthamani channel at Arapalayam during both winter and summer seasons. The highest value (3.8 mg L^{-1}) was recorded in Chottathati channel which was followed by (2.4 mg L^{-1}) Panaiyur channel during NEM season. The mean values of DO indicated that NEM recorded highest average value of 1.0 mg L^{-1} and the summer season recorded the lowest value was zero. Though the prescribed limit for dissolved oxygen is 5.0 mg L^{-1}, the DO content was registered as 0.0 mg L^{-1} in raw sewage water in all the 6 collection points at northern zone invariably during all the seasons, whereas in the south zone it ranged from 0.0 to 3.8 mg L^{-1}, The zero dissolved oxygen values may also be due to the stagnant and non-flushing conditions of the water with increasing waste load by regular addition of foods and pesticides. Very low DO content showed the presence of high organic matter which leads to the consumption of oxygen during its decomposition by the heterotrophs in water. These results are in accordance with the findings of Rajendran and Sekaran (2015). The DO content of Karamnariver at Thiruvananthpuram district, South Kerala ranged between 1.29 and 8.13 mg L^{-1}. The higher DO recorded during monsoon and post-monsoon seasons may be due to impact of rain water and lowest DO values exhibited as a result of the accumulation of oxygen demanding effluents (Jayaraman et al. 2003). Sandeep and Tiwari (2009) recorded DO content of treated distillery effluent of Ghazipur city was 2.0 mg L^{-1}.

Biological oxygen demand (BOD) of sewage effluent samples

The BOD is one of the important quality parameters which determines the suitability of the sewage water for aquatic organisms and irrigation in the sewage farm. From this above (Fig. 1), it is inferred that the sewage water was high BOD at some of the discharge points during the summer season. The highest BOD of 395 mg L^{-1} has been recorded at Chinthamani channel at Arapalayam during summer which was followed by Thathaneri (377 mg L^{-1}). Though the BOD levels lower than 395 mg L^{-1}, it was more than 300 mg L^{-1} in most of places during summer and

Table 2. Total coliforms (MPN / 100 ml) of raw sewage water samples.

Sl. No.	Collection points	South West Monsoon (Jun-Sep)	North East Monsoon (Oct-Dec)	Winter (Jan-Feb)	Summer (Mar-May)
North zone					
1.	K. K. Nagar	9	9	4	2
2.	Anna Nagar	6	4	4	2
3.	Anna Nagar Uzhavar Sandhai-New	17	14	7	4
4.	Mundirithoppu	27	34	11	7
5.	Thathaneri	17	14	7	6
6.	Vilangudi	11	8	7	5
South zone					
7.	Anuppanadi channel	9	7	7	4
8.	Panaiyur channel	4	4	2	2
9.	Santhaipettai	240	>2400	31	17
10.	Chottathatti channel	14	14	5	4
11.	Chinthamani channel at Arapalayam	17	14	9	7
Range					
Minimum		4	4	2	2
Maximum		240	2400	31	17
Mean		47.31	378.92	9.77	6.08
Standard deviation		68.71	720.00	7.85	4.25

winter seasons. The BOD of the SWM season ranged from 227 to 340 mg L^{-1} in 11 pumping stations across the MMC which is almost higher to prescribed limit (200–300 mg L^{-1}). Similar kind of results were also recorded in winter season from 280 to 355 mg L^{-1} which was also almost higher in prescribed limit. The NEM season recorded the lowest BOD ranged from 200.0 to 315.0 with a mean value of 253.7. The Anna Nagar and Thathaneri resulted the minimum BOD of 200.0 mg L^{-1} each, which was followed by Anuppanadi channel (235 mg L^{-1}). The NEM season data also revealed that some of samples were contain higher BOD level. The highest mean BOD value of 354.7 mg L^{-1} was recorded in summer season followed by winter season mean (324.5 mg L^{-1}) and the lowest mean BOD was observed in NEM (253.7 mg L^{-1}). As the BOD gives a quantitative index of the degradable organic substances in water and a measure of waste strength, higher BOD content had negative correlation as its usage i.e. the lower value is recommended for use, CPCB (2005). Gradual decline of BOD from monsoon followed by summer was attributed to decrease in temperature which in turn retards microbial activity. High concentration of organic matter in sewage water is reflected by its high BOD values (FAO 1985).

Chemical oxygen demand (COD) of sewage effluent samples (Fig. 2)

COD is an important parameter which decides the biological quality of the sewage water. The data on COD for the 11 pumping stations at various season viz., NEM, SWM, winter and summer were recorded in this Table 1. The 11 points during SWM recorded the maximum value of 458 mg L^{-1} and minimum value of 346 mg L^{-1} with a mean value of 397.2 mg L^{-1}. The 11 points during NEM recorded 310, 442 and 372.7 mg L^{-1} of low, high and average value of BOD respectively. The highest COD of 480 mg L^{-1} and lowest COD of 364 mg L^{-1} and average COD of 422.0 mg L^{-1} in the 11 pumping station during winter season. The maximum COD of 504 mg L^{-1} and the minimum COD of 396 mg L^{-1} and mean

value of 455.3 mg L^{-1} was recorded in 11 pumping station during summer season. The suppressed aquatic system has been recorded high COD always at summer season rather than other seasons and the lowest was recorded at NEM season. The highest COD of 504 mg L^{-1} was recorded at Munthirithoppu during summer season and the lowest COD of 310 mg L^{-1} at Vilangudi during NEM season. These results were in accordance with the results of Jena et al. (2010). On the basis of COD, the raw sewage water was rated as unsuitable for irrigation purpose as it crossed the prescribed limits of 250 mg L^{-1} for COD (Yadav et al. 2002). The higher values of COD might be due to the presence of chemically oxidisable organic matter present therein.

Total coliforms of sewage effluent samples (Table 2)

In north zone of Madurai Municipal Corporation, The highest value (34 MPN / 100 ml) of total coliforms was recorded in Munthirithoppu during NEM and lowest value (2 MPN / 100 ml) was recorded in K. K. Nagar and Anna Nagar during summer season. In south zone of Madurai Municipal Corporation, the lowest value (2 MPN / 100 ml) of was recorded in Panaiyur channel during both winter and summer seasons. The highest value (> 2400 MPN / 100 ml) was recorded in Santhaipettai during NEM season. The mean values of total coliforms indicated that summer season recorded lowest average value of 6.08 and the NEM season recorded the highest average value of 378.92 MPN / 100 ml. The highest level of total coliform might be due to the suspended organic material added to soil through sewage which serves as a source of energy for microbial population. Higher temperature in the summer seasons perhaps arrest the growth of microorganisms present in the sewage water. However, it was interesting to note a high count of actinomycetes even during the summer. Anandavalli (1986) also reported higher total coliform counts (up to 1×10^7 MPN / 100 ml) in some wells of Madurai city which had an open drainage nearby.

Conclusion

Seasonal variations act upon a number of factors that influence the toxicity of urban waste water and its effects in the receiving environment. The factors affected include dissolved oxygen concentrations in receiving waters, temperature of the waste water and the receiving environment, water levels and assimilative capacity, the types of contaminants that accumulate on urban surfaces. Other remediation techniques like bioremediation, phytoremediation, may be studied for the economical reclamation of the waste water irrigated land. Due to continuous application of sewage waste water, the water aquifer gets polluted resulting in increase in BOD and turbidity. Generally, the average application rate of sewage waste water permissible within application rates in any properly managed irrigation system. Continuous monitoring of waste water along with quality study will minimize the chances of further deterioration.

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