Assessment of Water Quality Parameters in Reference to Bacterial Population in Tapi River, Surat, Gujarat

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***Abstract*— The Physico-chemical parameters in reference to bacterial population that influence water quality of River Tapi was studied. Water samples were taken monthly from March-2015 to August-2015. Temperature, pH, dissolved oxygen, Nitrate, and Phosphate were selected for the study. The values of temperature and pH recorded in range of 33℃ to 24.7℃ and 7.38 to 8.31 (alkaline) respectively. Concentration of Nitrate and Phosphate were recorded higher at downstream with Depletion in Dissolved Oxygen. The number of total viable microbial counts and bacterial isolation and identification was done by using *Bergey's Manual of Determinative Bacteriology*. The result points out that *Gammaproteobacteria* and *Firmicutes* were prevalent species of microbial taxa represented among all sites. Presence of some pathogens including *Escherichia coli* was observed which indicates the sewage pollution.**

Keywords*— Tapi, Physico-chemical and Bacterial analysis, *Escherichia coli*, *Gammaproteobacteria*, *Firmicutes

I. INTRODUCTION

Rivers flowing through cities are often used as receiving body for treated and untreated urban wastewaters all over the world [1]. Some of these sewage-contaminated rivers are amongst the most extreme examples of ecosystems disturbed by human activities. The effect of wastewater discharge on the river depends on the flow of freshwater in river, the size of the city, the type of treatment applied to wastewater etc.

Sewage brings high loads of organic and inorganic pollutants which can modify the habitat of native freshwater bacteria. For instance, basic parameters such as temperature, pH and dissolved oxygen which are known as drivers of the bacterial community composition ([2],[3],[4]) in aquatic systems can be influenced by expanding human population, industrialization, intensive agricultural practices and discharges of massive amount of wastewater into the water bodies. The impact of these anthropogenic activities has been so extensive that water quality is deteriorated and the water bodies have lost their self-purification capacity to a large extent [5].

It is now well known that bacterial communities inhabiting aquatic ecosystems play key role in the biogeochemical cycling of organic matter and nutrients and thus sustaining the function and health of water ecosystems. [6], [7]. Despite of this much importance, bacterial diversity particularly in freshwater ecosystems is an under-valued national resource that deserves greater attention.

Tapi River plays important and significant role in economic growth and development of Surat. Various agricultural and anthropogenic activities and human interference could significantly influence water quality and also shape bacterial diversity in the water. So the main aim of the work was to determine water quality in reference to bacterial communities of the Tapi River.

II. MATERIALS AND METHODS

The water samples were collected from three different sites of River Tapi, Surat, Gujarat, India during the month of March to August, 2015 at monthly intervals. Three locations were selected for the study which is as follow.

1. Galteshwar (Freshwater Zone, up-stream, less disturbances)
2. Utran (Freshwater Zone, Inlet of domestic sewage, Anthropogenic pollution)
3. Ashwinikumar (Freshwater Zone, Inlet of domestic sewage, Anthropogenic pollution and cremation ground drainage)

The samples were collected in sterile containers and transported to laboratory for further analysis. The physico-chemical parameters such as pH, temperature, Dissolved Oxygen, Nitrate and Phosphate of water samples were measured using standard methods of APHA, 2005. pH and Temperature were recorded and dissolved oxygen was fixed at the site itself.

For bacteriological studies, a serial dilution of each sample was made and 0.1ml of each diluted samples was plated onto nutrient agar (Hi Media) plates to determine Total Viable Count (TVC). The results were expressed as Colony Forming Unit (CFU) per unit volume (mL), enumerated after 48 h of incubation [8]. Depending on the variations in colony morphology or colony characteristics, the isolates were separated and stored on nutrient agar slants at 4°C for further analysis.

The isolates were identified by using standard morphological, cultural, biochemical and physiological characteristics as per the *Bergey's Manual of Determinative Bacteriology.*

III. RESULTS AND DISCUSSION

Different water quality parameter values recorded during the study period are represented in Table I. Total viable count of the sample is analyzed and collected data are

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represented in Table II. Isolation and Identification of bacteria from the collected samples was carried out and obtained data are showed in Table III.

Highest pH- 8.31 at Utran during May-2015 which and lowest pH- 7.38 at galteshwar during July-2015 was noticed and almost pH values remained alkaline and did not show much fluctuation which represents the high buffering capacity of the river water.

Temperature of river water during May-2015 was comparatively higher and recorded in the range of 33℃ to 24.7℃ which may be because of seasonal changes.

TABLE I
Different Water Quality Parameters at 3 Sample Sites in 4 Months. G: Sampling Site at Galteshwar, U: Sampling Site at Utran, Ak: Sampling Site at Ashwinikumar.

Sr. No	Para-meters	Sites	May	June	July	August	Max.	Min.
1.	Temp. (℃)	G	32	30.3	26	24.7		
		U	33	28	26.5	26	33	24.7
		AK	33	28	26	25		
2.	pH	G	8.25	7.59	7.38	7.45		
		U	8.31	7.69	7.75	7.64	8.31	7.38
		AK	7.99	7.79	7.60	7.87		
3.	DO (mg/L)	G	10.13	9.52	6.28	12.36		
		U	7.50	8.51	7.09	8.71	12.36	6.00
		AK	7.70	6.89	6.00	8.31		
4.	NO_3 (mg/L)	G	2.359	1.608	0.548	1.359		
		U	9.907	7.933	3.768	3.137	9.907	0.548
		AK	6.406	2.178	2.989	2.653		
5.	PO_4 (mg/L)	G	0.187	0.128	0.088	0.187		
		U	0.428	0.296	0.420	0.231	0.428	0.088
		AK	0.405	0.268	0.363	0.278		

TABLE II
Data of Total Viable Count (TVC) of Sediments from 3 Different Sites in 4 Months

Sr. No.		Sites	May	June	July	August	Max.	Min.
1.	Water (TVC) CFU/ml	G	3.0×10^5	3.5×10^5	2.3×10^5	7.0×10^5	11.3×10^5	2.3×10^5
		U	5.0×10^5	5.8×10^5	4.1×10^5	10.6×10^5		
		AK	8.0×10^5	10.1×10^5	7.6×10^5	11.3×10^5		

Higher dissolved oxygen concentration observed during the August-2015 (12.36 mg/L) at galteshwar which might be due to the rainfall and the resultant freshwater mixing or presence of other oxidants. Values of dissolved oxygen recorded at Ashwinikumar were 6.00 mg/L in July-2015 which may be because of dilution towards downstream area.

Phosphate and Nitrate are the most important nutrients in freshwater ecosystem for the biodiversity and they critically affect the floral, faunal as well as microbial diversity of ecosystem. The average value of phosphate was recorded 0.344±0.048 and 0.328±0.033 for Utran and Ashwinikumar respectively which is quite high than that of galteshwar (0.147±0.024). The phosphates used as fertilizers in the agricultural fields and detergents used in households can be the possible sources of higher phosphate in Utran and Ashwinikumar sites.

Nitrate values ranged from 9.907 to 0.548 mg/L during the period of study and throughout the study, Samples collected from Utran were showed the highest nitrate concentrations which may be due to decomposition of organic wastes, oxidation of nitrite, disposal of higher organic matter as sewage etc.

The present study revealed the trend of high TVC in the water samples from Ashwinikumar and Utran sites than from Galteshwar as shown in table-2. Increased TVC at the downstream sites indicates the presence of pollution in water. In compare to Galteshwar (upper stretch), the water samples from Utran and Ashwinikumar showed the higher TVC. The samples from River Tapi at Ashwinikumar showed maximum TVC and this can be attributed to the location of the site (lower-stretch) as well as a number of human activities, interference of rituals taken place on bank, sewage disposal etc.

TABLE III.
Variations in Different Bacterial Species Exist.

Genera	Month	Selected locations		
		Galteshwar	Utran	Ashwinikumar
E. coli	May	-	✓	✓
	June	-	✓	✓
	July	-	-	-
	August	✓	✓	✓
Pseudomonas sp.	May	✓	✓	✓
	June	✓	✓	✓
	July	-	-	-
	August	✓	✓	✓
Klebsiella sp.	May	-	✓	✓
	June	-	✓	✓
	July	-	-	-
	August	✓	-	-
Staphylococcus sp.	May	-	✓	✓
	June	-	-	✓
	July	-	✓	-
	August	-	-	-
Bacillus sp.	May	-	-	-
	June	-	-	-
	July	✓	✓	✓
	August	-	-	-
Azotobacter sp.	May	-	-	-
	June	-	-	-
	July	-	-	-
	August	-	✓	-

TABLE IV
Summary (Average ± SE,) of Physico-chemical and Bacteriological Parameters at Different Locations

Parameters	Galteshwar	Utran	Ashwinikumar
Temperature (℃)	24.7 – 32 (28.25±1.73)	26-33 (28.375±1.6)	25-33 (28.00±1.78)
pH	7.38-8.25 (7.67±0.2)	8.31-7.64 (7.85±0.16)	7.60-7.99 (7.81±0.08)
DO	6.28-12.36 (9.57±1.26)	7.09-8.71 (7.95±0.39)	6.0-8.31 (7.22±0.5)
Nitrate	0.548-2.359 (1.47±0.37)	3.137-9.907 (6.19±1.63)	2.178-6.406 (3.56±0.96)
Phosphate	0.088-0.187 (0.147±0.024)	0.231-0.428 (0.344±0.048)	0.268-0.405 (0.328±0.033)
TVC (CFU)	230000-700000 (395000±104602.4)	410000-1060000 (637500±145050.3)	760000-1130000 (925000±87607.08)

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Different bacteria according to their morphological characteristics were isolated and the isolates were identified based on the morphological and biochemical characterization as per *Bergey's Manual of Determinative Bacteriology*. The bacterial isolates found are belonging to 6 genera i.e. *Pseudomonas sp.*, *Staphylococcus sp.*, *E.coli*, *Klebsiella sp.* and *Azotobacter sp.* and *Bacillus sp.* from two major phyla i.e. *Gammaproteobacteria* and *Firmicutes.* The most frequently found bacterial isolate was *Pseudomonas sp.*, followed by *Klebsiella sp.* and *E.coli* while the least abundant bacteria were *Staphylococcus sp.*

Higher concentration of Phosphate and Nitrate at the downstream stretch may be responsible for the higher bacterial load. Similar results were observed by Yanamadala, 2005 [9]. where he stated that one possibility of decreasing bacteria populations in this water was decreased nutrient concentrations in the water. Although, the possibility of anthropogenic activities and urban wastewater discharge interference cannot be avoided. Presence of coliform including some pathogenic genera such as *E. coli*, *Pseudomonas*, *Staphylococcus* etc. in sediment indicate the anthropogenic activities and other discharges.

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