RESEARCH ARTICLE

Physicochemical Analysis of Flowing water of two Rivers of the Pune City, Maharashtra, India

Manohar G. Gavit, Mohd. Shahnawaz, Manisha K. Sangale, Halimabi A. Kureshi and Avinash B. Ade*

Department of Botany, University of Pune, Pune - 411007, Maharashtra, India

ABSTRACT

Pune city is one of the emerging cities of the Modern India. Three major rivers (Pavana, Mula and Mutha) are flowing through this city. All the domestic sewage, industrial effluents and solid waste find its way to these rivers via channels which affect the quality of flowing water and also creating health problems. In the present study an attempt has been made to assess the flowing water pollution in the Pune city. 14 physicochemical parameters were analyzed. Among the two rivers, Mutha was found highly polluted.

INTRODUCTION

Out of the total land water only 1% is available for agriculture, drinking, domestic, power generation, industrial consumption, transportation and waste disposal (Mishra *et al*., 2002; Gupta *et al*., 2008; Tahir *et al*., 2008). Pune city is one of the emerging cities of the Modern India in terms of its fast growth and development. Its development has direct or indirect effect on its environment. Three rivers namely Mula, Mutha and Pavana are flowing through the Pune city. People living near the rivers directly pollute the water by taking bath, washing cloths, vehicles and utensils in it. All the domestic sewage, industrial effluents and solid waste also find its way to the rivers via channels and lead to affect the quality of flowing water and creating health problems (Raja *et al*., 2002). The physical, chemical and biological characteristics of water determine the quality of water (Diersing, 2009). The significant changes in these physicochemical parameters lead to assess the quality of the water (Dhembare *et al*., 1997). Various workers assessed the physiochemical characteristics of the flowing water of Mutha, Mula and Pavana Rivers of the Pune city in the past (Gunale and Patwardhan, 1997). In the present study an attempt has been made to assess the level of pollution in the flowing water of Mutha and Pavana rivers in terms of changes in physicochemical parameters.

MATERIALS AND METHODS

Collection of water samples

Water samples were collected from 6 sampling sites of the rivers Mutha and Pavana (Table 1, Fig. 1). From the localities of Pavana and Mutha Rivers, the samples were collected during winter season 2011. The water sampling was performed as per Zamxaka *et al.* (2005). From each locality three water samples were collected randomly in the canes (1L). Except for Dissolved Oxygen (DO), where BOD bottles (300ml, glass stopper) were used for sample collection and samples were brought to the working station.

Corresponding author: avinashade@unipune.ac.in

The temperature of the water samples were recorded at the time of collection using a mercury thermometer.

Physico-chemical analyses of water samples

Following key parameters such as pH, temperature, total dissolved solids (TDS), dissolved oxygen (DO), chemical oxygen test, total hardness (TH, chlorides (Cl), nitrate (NO_3), sulphate (SO4), phosphate (PO4), calcium hardness, magnesium hardness, free carbon dioxide and total alkalinity (TA), biological oxygen demand (BOD) and chemical oxygen demand (COD), were determined using standard method of American Public Health Association, (1998). All the solutions were prepared using single distilled water and the reagents were of AR grade. The results were compared with the standards of water quality as per World Health Organization, (2004) to assess the level of water pollution in the Mutha and Pavana rivers.

Table 1. Details of the water sample collection sites

Sr. No.	Name of the locality	Name of the river/dam
1	Bopodi	Pavana river
2	Aundh	Pavana river
4	Shivajinagar	Mutha river
5	MNPA	Mutha river
6	Deccan	Mutha river

RESULTS AND DISCUSSION

The analyses of physico-chemical parameters are shown in the Table 2. The results were also compared with the available standard values of some parameters as per World Health Organization (2003, 2004) and ISI 1050091/CPHEEO (Venkateswara, 2011).

pH

The value of pH was found within the limits as per standards the highest average pH (8.23±0.02) was recorded in water samples collected from Sangavi whereas the average lowest pH (7.1±0.05) was recorded in water samples of Shivajinager. Usually rivers with pH 5.5 or less are considered at risk (Sawyer *et al*., 1978).

Table 2. Details of Physicochemical characteristics of the water samples collected from Mutha and Pavana rivers of the Pune city

Sampling points	replicates	pH	TDS (g/L)	TA (mg/L)	Cl (mg/L)	DO (ppm)	BOO (mg/L)	COD mg/L	TH mg/L	Ca Hardness (mg/L)	Mg hardness (mg/L)	SO$_4$ (mg/L)	PO$_4$ (mg/L)	NO$_3$ (mg/L)	Free CO$_2$
WHO		7-8.5	500-1000 (mg/L)	120	250	-	-	-	200-600	-	-	250	-	5	-
ISI1050091 /CPHEEO		6.5-8.5	500-1500	200	250	5.0	-	-	-	-	-	200	-	45	-
Shivaji nagar	1	7.1	7.6	14.33	8.0	3.6	4.6	17.5	222	14.2	112	8.2	1.0	8.0	1.6
	2	7.1	8.0	16.3	8.7	3.7	3.5	21.5	253	15.2	80	8.7	1.1	7.0	1.6
	3	7.2	8.8	12.2	9.0	3.2	4.0	18.0	252	14.0	100	9.0	1.6	8.0	1.2
	∑	7.1	8.1	14.2	8.56	3.5	4.03	19.0	242.3	14.46	97.3	8.6	1.23	7.6	1.4
	SD	0.05	0.61	2.05	0.51	0.26	0.55	2.17	17.61	0.64	16.16	0.40	0.32	0.57	0.23
MNPA	1	8.2	10.5	120	12.2	1.5	7.5	71.5	540	180	250	12.5	2.7	18	3.9
	2	8.2	10.9	150	13.2	1.2	8.0	63.0	460	175	212	13.0	2.8	18	2.0
	3	8.1	11.5	102	12.5	1.9	9.0	70.0	524	130	230	13.9	2.0	19	2.2
	∑	8.1	10.9	124	12.6	1.5	8.16	68.16	508	161.6	230.6	13.1	2.5	18.3	2.7
	SD	0.05	0.50	24.24	0.51	0.35	0.76	4.54	42.33	27.53	19.00	0.70	0.43	0.57	1.01
Deccan	1	7.3	7.5	50	8.3	2.1	2.0	22.0	312	90	80	9.0	0.9	14	2.6
	2	7.8	7.5	55	8.5	1.9	3.0	26.0	320	75	105	8.1	1.0	15	2.4
	3	7.1	7.6	51	8.7	1.6	3.1	24.5	298	68	60	9.2	1.6	14	2.3
	∑	7.4	7.5	52	8.5	1.8	2.7	24.16	310	77.6	81.6	8.7	1.1	14.3	2.4
	SD	0.36	0.05	2.64	0.2	0.25	0.61	20.20	11.13	11.23	22.54	0.58	0.37	0.57	0.15
Bopodi	1	8.1	8.9	105	9.7	1.1	9.0	44.0	343	201	150	14.1	2.9	20	3.66
	2	8.2	8.10	85	9.8	0.9	10.5	57.0	350	150	300	14.6	2.8	21	3.65
	3	8.4	8.0	70	10.0	1.0	11.5	58.2	360	187	290	13	2.7	19	3.70
	∑	7.6	8.3	86.6	9.8	1.0	10.33	53.06	351	179.3	246.6	13.9	2.8	20	3.6
	SD	0.15	0.49	17.55	0.15	0.1	1.25	7.87	8.54	26.35	83.86	0.81	0.1	1.0	0.02
Aundh	1	7.2	6.5	60	7.5	2.1	5.6	11.2	260	30.3	60	8.6	0.6	5.0	1.0
	2	7.2	6.0	75	7.5	2.0	4.4	18.9	290	33	45	6.0	0.87	5.0	1.52
	3	7.4	6.90	62	7.9	2.5	5.0	16.0	278	35.1	50	7.1	1.0	5.5	1.6
	∑	7.2	6.4	65.6	7.6	2.2	5.0	15.36	276	32.8	51.6	7.2	0.8	5.1	1.3
	SD	0.11	0.45	8.14	0.23	0.26	0.60	3.88	15.09	2.40	7.63	1.30	0.20	0.28	0.32

(∑: Average; SD: Standard deviation)

Total Dissolved Solids (TDS)

The average TDS was recorded in the range of 6.4±0.45g/L (Aundh) to 10.9±0.5g/L (MNPA) which is very high as compared to maximum permissible limit (1000 mg/L: WHO, 2003).

Total Alkalinity (TA)

The lowest average TA (14.2±2.05mg/L) was recorded in water samples collected from Shivajinager whereas the highest average TA (124±24.24mg/L) was found in case of MNPA. Our result is in agreement with the previous report (Kshirsagar and Gunale, 2011).

Chlorides (Cl)

The average concentration of the Cl was found in between 7.6±0.23mg/L (Aundh) and 12.6±0.1mg/L (MNPA).

Dissolved Oxygen (DO)

Among all the sampling points DO varied from 1.0 ± 0.01 ppm (Bopodi) to 3.5 ± 0.26 ppm (Shivajinager). The concentration of DO among all rivers was very low. The possible reasons for the low DO concentrations are: (1) due to presence of the material with rich organic content responsible for depletion of oxygen, (2) the rate of deoxygenation due to bio-degradation of the organic substances is higher than the rate of reoxygentaion from the atmosphere, or (3) may be due the oxidizable minerals present in the aquifer (Das and Acharya, 2003; Abdullah and Aris, 2005).

Total Hardness (TH)

The maximum (242.3±17.61 mg/L) and minimum TH (508±42.33 mg/L) was recorded in the samples collected from Shivajinagar and MANPA respectively.

Nitrate (NO$_3$)

The samples collected from Aundh showed maximum nitrate contents (5.1±0.28 mg/L) where as the least nitrate content (20±1.0 mg/L) was recorded in the samples collected from Bapodi.

Sulphate (SO$_4$)

The sulphate content also varied from 8.6±0.40 mg/L (Shivajinagar) to 13.9±0.81 mg/L (Bapodi) respectively.

Phosphate (PO$_4$)

Minimum 0.8±0.20 mg/L phosphate content was reported in the samples collected from Aundh where as maximum 2.8±0.01 mg/L was found in the samples collected from Bapodi.

Calcium hardness

The collected samples exhibit huge variation interms of calcium hardness. The minimum 14.46±0.64 mg/L and maximum 179.3±26.35 mg/L calcium hardness was reported in the samples of Shivajinagar and Bapodi respectively.

Magnesium hardness

The samples collected from Aundh had minimium magnesium hardness 51.6±7.63 mg/L whereas the samples collected from the Sangavi recorded maximum 248.6±44.45 mg/L magnesium hardness.

Fig.1. Details of the localities of the water sample collection A: Bopodi, B: Aundh, C: PMC, D: Shivajinagar, and E: Deccan

Free Carbon dioxide

The free carbon dioxide varied from 1.3±0.32mg/L (Aundh) to 3.6±0.02mg/L (Bapodi) among the collected samples.

Biological Oxygen Demand (BOD)

The sample collected from Bapodi reported to have the highest BOD i.e. 10.03 ±1.25 mg/L where as the least BOD i.e., 2.7± 0.60 mg/L was recorded in case of samples collected from Deccan.

Chemical Oxygen Demand (COD)

A huge variation in COD was recorded among the collected water samples. The maximum 74.66±8.38 mg/L and minimum 19.0±2.18 mg/L were recorded in the samples collected from Sangavi and Shivajinagar respectively. The permissible limit of COD is 10mg/L (Usharani *et al*., 2010). The COD value in the current study exceeds the permissible limit about 2 to 7.4 times. The high value of COD indicates the direct entrance of large quantity of untreated sewage into the rivers.

Conclusion

Based on the study carried out it be concluded that the poor water quality may be due to domestic sewage in case of Mutha river and Civil industrial effluents in case of Pavana River. Dissolved oxygen was found very critical at many places of these rivers and at some places it is below the detectable level causing a threat to aquatic life. High level of BOD and COD confirm excess of this oxygen demanding waste. It is cleared from the present findings that the aquatic environment of Mutha and Pavana rivers flowing through the

Pune city shows increasing load of pollution and lead remedial measure. There is a need to have proper collection and treatment of waste. As also to restore the river in wetland there is a need to regulate the flow and degrade the deposited material.

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