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Original Research Paper

Water Quality and Pollution Status of Chalakudy River At Kathikudam, Thrissur District, Kerala, India

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ABSTRACT

The present investigation deals with the analysis of water quality of Chalakudy river near Kerala Chemicals and Proteins Ltd. (KCPL) at Kathikudam, Thrissur district, Kerala. Water samples were collected monthly for a period of six months from March to August 2007 at 3 sites of Chalakudy River. Low dissolved oxygen, high values of conductivity, total hardness, biochemical oxygen demand, turbidity, nitrate and phosphate show unhealthy condition of the river. The conductivity, turbidity and pH of the water samples were not within the permissible limit in the site near KCPL during the period of study.

INTRODUCTION

The river water resources in Kerala state are subjected to substantial stress due to changes in riverine ecology (Sankar et al. 2002, Harilal et al. 2004). Pesticides and chemical fertilizers used for agriculture and the industrial wastes are polluting the rivers of Kerala (Nair 1997). The environmental status and the water quality of Chalakudy river has been continuously changed (Padmalal et al. 2004, Chattopadhyay et al. 2005). Babu & Maya (1997) made an earlier assessment of the drinking water quality around Kerala Chemicals and Proteins Ltd. (KCPL) at Kathikudam, Thrissur district.

An ossein plant in operation generated wastewater with an effluent having higher chemical oxygen demand and suspended solids (Badrinath et al. 1991). The influence of the ossein effluent on *Oscillatoria pseudogeminata* var. unigranulata was investigated by Manoharan & Subramanian (1996).

MATERIALS AND METHODS

Kerala Chemcials and Proteins Ltd. (KCPL) is located near the Chalakudy river at Kathikudam in Kadukutty panchayat, Kerala. The company KCPL started operations in 1979 and produces ossein ($C_{102}H_{149}N_{31}O_{38}$), an intermediary product in the processing of gelatin. The raw materials used are crushed bones of animal origin and HCl (35%). The by-product is dicalcium phosphate.

The present analysis was conducted at three sites in Chalakudy river. The study area lies between 10°13’33” to 10°17’33” N latitudes and 76°17’32” to 76°20’20” E longitude. The site 2 (S_2) is at Kathikudam near the company KCPL. The other sampling sites are Taikkuttamkadavu (S_1, upstream) and Pulikkakadavu (S_3, downstream) of Chalakudy river (Fig. 1). The surface water samples were collected for a period of six months from March to August 2007. The samples were carried to the laboratory for the analysis of physicochemical parameters. The temperature, turbidity, conductivity, pH, acidity, alkalinity, total hardness, total dissolved solids (TDS), chloride, free carbon dioxide (CO_2), dissolved oxygen (DO), nitrate, phosphate, silicate, biochemical oxygen demand (BOD) and chemical oxygen demand (COD) are the parameters analysed (APHA 1998, Maiti 2001).

RESULTS AND DISCUSSION

The study revealed that hydrographic parameters fluctuated with season and location (Table 1). Every parameter studied showed fluctuations during monsoon season (June to August) due to heavy rainfall. Monthly fluctuations of hydrographic parameters of water studied at the three stations are given in Figs. 2 to 17.

The temperature varies from 23 to 30°C (Table 1 and Fig. 2). Temperature was high during pre monsoon season and low in monsoon season. The oxidation of organic matter is highly influenced by temperature of the water and the effluents with higher temperature from various industrial sources alter the natural conditions of the river (Koshy 2003).

The turbidity values range from 0.6 to 27.4 NTU during the period of study (Fig. 3). The average value of turbidity of water was higher in S_3 during premonsoon season and higher in S_2 during monsoon season (Table 1). According to the Bureau of Indian Standards (BIS 1991) the permissible limit of turbidity in the inland surface water is 2.5 NTU. The turbidity values observed at S_3 in April (27.4 NTU), at S_1 (13.8 NTU) and S_2 (14 NTU) in June were high and not in the permissible limit. The discharge of untreated industrial and domestic effluents adds great quantities of turbidity (Maiti 2001). The reason for the higher values of turbidity at S_3 during premonsoon was due to the dumping of domestic wastes with the addition of industrial effluents from the upstream of the river.

According to BIS the permissible limit of conductivity is 250 µmhos/cm. The conductivity fluctuated between 12 to 559 µmhos/cm during the period of study. Comparatively, higher values were exhibited at S_2 (Table 1 and Fig. 4) and the values exceeded the BIS standards during April (267 µmhos/cm), May (265 µmhos/cm), June (314 µmhos/cm) and August (559 µmhos/cm).

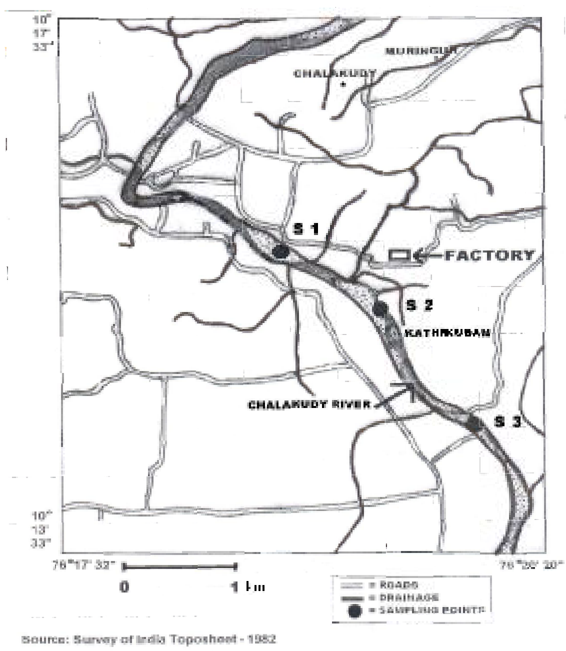

Fig. 1: Sampling sites.

The pH of Chalakudy river ranged from 5.65 to 6.76 during the period of investigation. The water of Chalakudy river in the study area was, thus, acidic in nature. The S_2 was more acidic than other two sites (Table 1 and Fig. 5). The desirable limit for drinking water is between 6.5 and 8.5 (BIS 1991), and all sites were not in permissible limit during premonsoon season. The higher acidic nature of S_2 can be attributed to the release of effluents into the river. The average value of acidity showed that the S_3 was more acidic than other two sites during pre monsoon, and at S_2 during monsoon season (Table 1 and Fig. 6). During premonsoon season the highest average value (17.33 mg/L) recorded from S_3 was due to the addition of domestic waste with the addition of industrial effluents from the upstream of river. During monsoon season the highest value of 34 mg/L was recorded at

Table 1: Seasonal fluctuation of physicochemical parameters at three sites in the river.

Sl. No:	Parameters	Site~	Pre monsoon Range	Pre monsoon Mean± SD	Monsoon~ Range	Monsoon~ Mean± SD	Permissible limit (BIS 1991)
1	Temperature, °C	1	26.8-30	28.93±1.85	24-27	25.67±1.53	~
~		2	26.3-29.8	28.37±1.83	24-27	25.67±1.53	-~
~ ~		3	26.30-30	28.73±2.11	23-28	25.67±2.52	~
2	Turbidity, NTU	1	0.8-2.4	1.63±0.8	0.6-13.8	5.2±7.45	~
~		2	1.3-2.1	1.7±0.4	1.2-14	5.53±7.33	2.5 NTU
~ ~		3	0.9-27.4	10.7±14.54	0.7-8.6	3.8±4.22	~
3	EC, µmhos/cm	1	55-61	58.8±3.3	40-68	52.33±14.29	~
~		2	131-267	221±77.95	78-559	317±240.51	250
~ ~		3	12-89.2	60.73±42.4	49-105	73.33±28.71	~
4	pH	1	5.66-6.22	6.01±0.31	6.33-6.71	6.55±0.2	~
~		2	5.65-6	5.83±0.18	6.09-6.76	6.52±0.38	6.5 - 8.5
~ ~		3	5.98-6.09	6.02±0.06	6.32-6.52	6.40±0.1	~
5	Acidity, mg/L	1	8-18	12.67±5.03	8-18	11.33±5.77	~
~		2	10-18	14.67±4.16	8-34	19.33±13.32	-~
~ ~		3	14-22	17.33±4.16	2-8	5.33±3.06	~
6	Alkalinity, mg/L	1	18-70	36.67±28.94	20-40	28±10.58	~
~		2	22-84	57.33±31.9	26-62	40±19.29	200~
~ ~		3	20-82	41.33±35.23	22-48	34.67±13.01	~
7	TDS, mg/L	1	22-24.4	23.52±1.32	16-27.2	20.9±5.73	~
~		2	52.4-106.8	88.4±31.18	31.2-223.6	126.8±96.21	500~
~ ~		3	4.8-35.68	24.29±16.96	19.6-42	29.33±11.48	~
8	Total hardness,	1	26-70	41.33±24.85	18-26	22.67±4.16	~
~	mg/L	2	40-94	72±28.35	32-200	116.33±84	300~
~		3	28-92	51.33±35.35	22-44	34.67±11.37	~
9	Free CO_2, mg/L	1	7.04-15.84	11.15±4.43	5.28-15.84	9.09±5.86	~
~		2	8.80-14.96	12.61±3.33	13.2-22	17.01±4.52	-~
~ ~		3	13.2-20.24	15.55±4.06	12.32-20.24	15.52±4.17	~
10	DO, mg/L	1	4.8-5.6	5.23±0.4	5.8-6	5.93±0.12	~
~		2	2.3-4.6	3.83±1.33	3.8-5.9	4.63±1.12	-~
~ ~		3	1-5.2	3.37±2.15	5-5.4	5.23±0.21	~
11	BOD, mg/L	1	0.8-1.8	1.33±0.5	2-5.2	3.6±1.6	~
~		2	2.8-7.2	4.4±2.43	2.8-4.4	3.47±0.83	~
~ ~		3	0-4.4	2.53±2.27	2.4-3.6	2.93±0.61	~
12	COD, mg/L	1	3-4	3.33±0.58	3-13	8.67±5.13	~
~		2	6-16	9.67±5.51	6-11	8.33±2.52	-~
~ ~		3	2-10	6.33±4.04	5.00-9	7±2	~
13	Chloride, mg/L	1	16-32	22.67±8.33	20-26	22±3.46	~
~		2	40-94	67.33±27.01	22-15	81.33±64.51	200~
~ ~		3	20-24	22.67±2.31	16-34	27.33±9.87	~
14	Nitrate, mg/L	1	1.77-2.22	2.07±0.26	2.22-30.2	11.55±16.15	~
~		2	2.66-3.98	3.25±0.67	2.66-38.54	19.94±17.98	45~
~ ~		3	2.22-13.73	6.2±6.52	2.22-12.42	6.36±5.37	~
15	Phosphate, mg/L	1	0.01-0.03	0.02±0.01	0.01-0.02	0.01±0	~
~		2	0.03-0.17	0.09±0.07	0.02-0.42	0.22±0.2	-~
~ ~		3	0.02-0.07	0.04±0.03	0.02-0.03	0.02±0.01	~
16	Silicate, mg/L	1	3-5.6	4.6±1.4	2.9-5.3	4±1.21	~
~		2	3.8-7.6	5.27±2.04	3.9-4.7	4.27±0.4	~
~ ~		3	3-4.2	3.53±0.61	2.2-5.2	3.9±1.54	~

S_2, and the average value was 19.33 mg/L.

The average values of alkalinity were found to be higher in the S_2 than other two sites during both

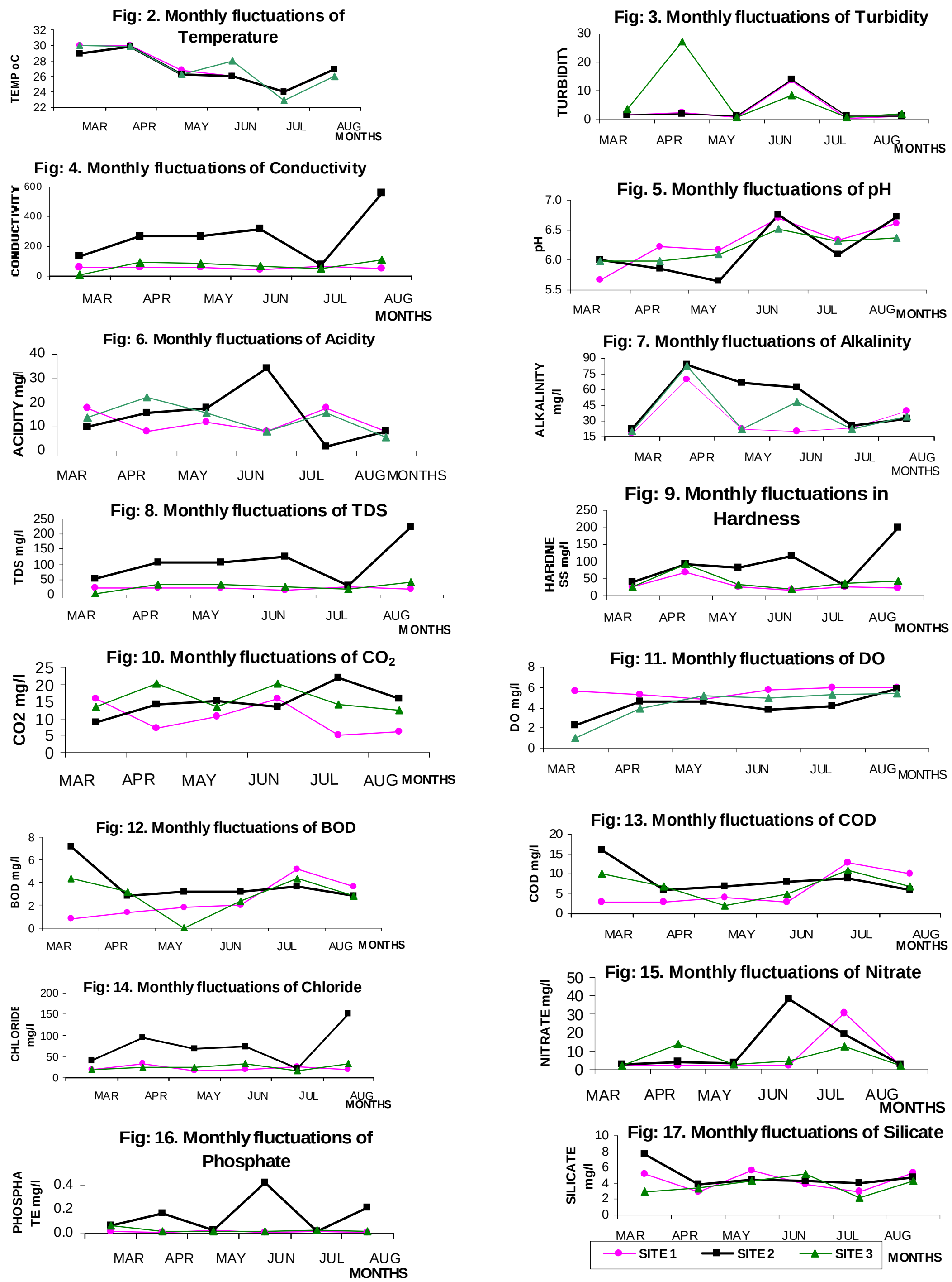

Fig. 2-17: Monthly fluctuations of physicochemical parameters in the river.

premonsoon and monsoon seasons (Table 1 and Fig. 7). The wastewater discharge from the industries and settlements and microbial decomposition of organic matter, present in the surface water bodies, are the alkalinity inducing components (Prameena & Abbasi 2001). High alkalinity in river water indicates high pollution load (Koshy & Nayar 2001). The high values of alkalinity at S_2 during both premonsoon and monsoon may be due to the release of effluents into the river water.

The average values of TDS showed higher values in S_2 compared to other two sites during premonsoon and monsoon seasons. This site was near KCPL, the ossein producing company (Table 1 and Fig. 8). According to (BIS 1991) the permissible standards for TDS is 500 mg/L and, therefore, the water quality was within the limit during the period of study for TDS.

The total hardness varies from 18 to 200 mg/L. In the monsoon season, there was a considerable decrease at both S_1 and S_3 but there was increase during this period in S_2 (Table 1 and Fig. 9). The increase in hardness in S_2 can be attributed to the release of industrial effluents from KCPL Ltd. Trivedy & Goel (1984) and Singh & Singh (1990) reported that high hardness indicate the pollution of waters. As per BIS (1991), the permissible limit of hardness for drinking water is 300 mg/L, and the value of hardness in the study area was in permissible limit. According to Maiti (2001) the waters with hardness up to 75 mg/L are soft, 75-150 mg/L moderately hard, 150-300 mg/L hard, and above 300 mg/L very hard. During premonsoon season waters in all the sites were generally soft. But the values during April (94 mg/L) and May (82 mg/L) at S_2 and April (92 mg/L) at S_3 show moderate hardness. In monsoon season the S_2 was moderately hard and the values during June (117 mg/L) and August (200 mg/L) were comparatively higher.

In S_3 the free CO_2 values were higher than the other two sites during premonsoon. The higher values were found at S_2 during monsoon season (Table 1 and Fig. 10). Polluted water acquires CO_2 by biological oxidation of organic matter, and high CO_2 level indicates pollution (Koshy 2003). The high value of CO_2 at S_3 during premonsoon season was due to the decomposition of organic wastes dumped in to the river.

In the present study dissolved oxygen was low at S_2 and S_3 during premonsoon (Table 1 and Fig. 11). The reason for the lower values of DO at S_2 may be due to the release of oxygen demanding industrial wastes into the river by KCPL. At S_3 its effect was higher due to the addition of domestic waste into the river. The DO of Chalakudy river ranges from 1 to 5.6 mg/L during premonsoon season and from 3.8 to 6 mg/L during monsoon season. The seasonal and monthly values of BOD and COD are depicted in Table 1 and Figs. 12 and 13. Comparatively higher values were observed in S_2 during premonsoon. Higher values of BOD and COD were recorded from the S_2 during both premonsoon and monsoon. The BOD determines the level of organic pollution in the river system.

The seasonal and monthly fluctuation of chlorides is given in Table 1 and Fig. 14. The chloride at S_2 showed high values when compared to other two sites. The high values of chloride recorded were 150 mg/L during monsoon season in the month of August and 94 mg/L during premonsoon season in the month of April in S_2. According to BIS (1991) the desirable limit of chloride for drinking is 200 mg/L. The values of chloride were usually between 2 and 10 mg/L in unpolluted rivers.

The higher values of nitrate were found at S_3 during premonsoon and at S_2 during monsoon season (Table 1 and Fig. 15). The higher values of nitrate at S_3 during premonsoon season were due to dumping of wastes. Highest value of nitrate recorded in the present study was 38.54 mg/L from S_2 in the month of June. The high concentration of nitrates in water resources increases the growth of algae and triggers eutrophication.

Phosphorus is essential nutrient for the growth of organisms and can limit the primary productivity of waters. Phosphates are usually present in low quantities in natural unpolluted rivers mostly ranging between 0.005 and 0.02 mg/L. During the period of study phosphate values varied from 0.01 to 0.42 mg/L. Higher values of phosphate were recorded at S_2 during both premonsoon and monsoon seasons. The higher values of phosphorus at S_2 may be due to the contribution of phosphate from KCPL factory. The phosphate values of S_1 and S_2 decreased during monsoon season due to the rainfall, whereas it increased in S_3 (Table 1 and Fig. 16).

Higher values of silicate were found at S_2 both during premonsoon and monsoon seasons (Table 1 and Fig. 17). The silicate values ranged from 2.2 to 7.6 mg/L during the period of study. The conductivity, turbidity and pH were not within the permissible limit in the sites studied near KCPL during the period of study. The analysis of physicochemical parameters of the water indicates that site 2 near the KCPL was more polluted than the other two sites. In the premonsoon season, the S_3 was also found to be polluted due to dumping of domestic wastes. The present study of Chalakudy river revealed that quality of the water was deteriorated.

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