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Study on the Physico Chemical Properties of Water of Mouri River, Khulna, Bangladesh

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Abstract: Water sample were collected from six different point of the Mouri River Khulna, Bangladesh with a regular intervals in the months of January-March 2002 for the analyzing different physicochemical parameters of the water. Total 22 different physicochemical parameters were investigated. Correlation and the t value among the parameters were also determined. In the present investigation the minimum and maximum value of water temperature, Transparency, Turbidity, TSS, TDS, Electric Conductivity, water pH, dissolve oxygen, free Carbon dioxide, Alkalinity, Acidity, Hardness, BOD, COD, Sulphate, Phosphate, Nitrite, Sodium, Calcium, Potassium, Manganese and Iron were noted as 21.6 and 32.2°C; 15 and 66 cm; 16 and 22 NTU; 74 and 125 mg L^{-1}; 255 and 305 mg L^{-1}; 159 and 275 μS cm^{-1}; 1.10 mg L^{-1} 8.18 mg L^{-1}; 7.5 and 8.3; 1.1 and 8.3 mg L^{-1}; 27.5 and 35.5 mg L^{-1}; 350 and 610 mg L^{-1}; 32.4 and 171 mg L^{-1}; 310 and 529 mg L^{-1}; 13 and 31 mg L^{-1}; 290 and 365 mg L^{-1}; 42046 and 57.35 mg L^{-1}; 4.89 and 11.46 mg L^{-1}; 0.54 and 1.82 mg L^{-1}; 16.8 and 33.9 mg L^{-1}; 1.5 and 6.9 mg L^{-1}; 49 and 94 mg L^{-1}; 31 and 59 mg L^{-1}; 2.6 and 3.8 mg L^{-1}, respectively. River water did not show any significant pollution during the present study. During the study period dissolved oxygen show direct relation with water temperature but inverse with BOD and COD.

Key words: Physcio-chemical parameters, water quality, correlation, pollution, river Mouri

INTRODUCTION

Quality of water generally refers to the component of water, which is to be present at the optimum level for suitable growth of plants and animals. Various factors like temperature, turbidity, nutrients, hardness, alkalinity, dissolved Oxygen play an important role for the growth of plants and animals in the water body, on the other hand biological Oxygen demand, chemical Oxygen demand indicate the pollution level of the water body. In natural aquatic system, various chemical parameters occur in low concentration. This concentration increases as a result of rapid growth of population, increased urbanization, expansion of industrial activities, exploitation of natural resources, extension of irrigation and lack of environmental regulations (Mehedi *et al*., 1999). A number of published data shows that there are some relationships among the water quality parameters (Jana, 1979; Nair *et al*., 1980; Hannan *et al*., 1978; Qaddri *et al*., 1991).

Mouri is a dead river situated the western side of Khulna city, which plays an important role for fisheries. This river receives all types of municipal wastes through sewages outfall, which contains various organic and inorganic nutrients and other pollutants. These pollutants cannot be washed way due to its ephemeral character and thus they are accumulated in the river system gradually. Most published data on the effects of pollutants on aquatic organisms however provides the report of adverse effects at concentration higher than acceptable limit (GESAMP, 1985).

Aquatics organisms need a healthy environment to live and have adequate nutrients for their growth. The productivity depends on the physico chemical characteristics of the water body. The maximum productivity obtained when the physical and chemical parameters are at the optimum level. Water quality plays an important role in decision making process for pollution control. Researches on the water quality aspects are of paramount significance in developing fresh water quality. Therefore water quality is paramount factor in ecosystem productivity (Huet, 1986). Information is not available on the water quality of Mouri river but this river plays an important role for fisheries. The aim of the present investigation was to determine the values of major physico-chemical parameters of the water of Mouri river and to establish the correlations among the different parameters.

MATERIALS AND METHODS

Sampling stations: The working stations were established with more or less similar distances and near the drainage openings to the Mouri river, Khulna. The six working

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stations with a more or less regular distance by name were: Station-I: Rayer Mohal, Station-II: Boyra, Station-III: Gollamari Station-IV: Nirala, Station-V: Nirala-west and Station-VI was Laboncharat. From the above six stations samples were collected in the month of January, February and March 2002 at regular fortnightly intervals.

Sample analysis: Water temperature (mercury filled celcius thermometer), transparency (secchi disc method), turbidity (Nephelometric method, Systronic type No. 131), pH (Electronic digital instrument, model T-MS 30) and electrical conductivity (electrometric method) were estimated at the spot (Saxena, 1998) and rests of the parameters were determined in the laboratory within five hours of collection.

Total suspended solids were measured by oven-dried method (Wyckoff, 1964); total dissolved solids were estimated by filtration and oven dried method (Smith and Greenberg, 1963). Acidity was measured by titration method (Brown *et al*., 1970; Britton, 1956); dissolved oxygen was measured Winkler-azide modification method (APHA, 1985). Free carbon dioxide was measured titration method (APHA, 1985); Alkalinity was measured by titration method (Jenkins and Moore, 1977). Hardness was estimated by following EDTA titration method (Connors, 1950; Betz and Noll, 1950). Calcium and magnesium was measured by gravimetric method (Saxena, 1998). Biochemical oxygen demand (BOD_5) was measured by 5 day BOD test (UEPA, 1986). Chemical Oxygen Demand (COD) was measured by open reflux method (Moor *et al*., 1949). Sulfate was measured by gravimetric method with drying residue (Hillebrand, 1953; Kolthoff *et al*., 1969); Phosphate was estimated by stannous chloride method (Saxena, 1998). Nitrite was estimated by colorimetric method (APHA, 1985). Sodium and potassium was measured by using the Flame photometer (Burner unit 121, Digital FOPM-125) (Saxena, 1998). Total iron was measured by Spectrophotometer (phototube 880 nm) phenanthroline method (APHA, 1985). Three replicated analysis were done for each parameter in each sampling.

Correlation coefficient: Correlation coefficient (r) was calculated to know the relationship in between and anomg the parameters by using the following formula:

$$r = \frac{n.\sum xy - \sum x \sum y}{\sqrt{\left(n\sum x^2 - \left(\sum x\right)^2\left(n\sum y^2 - \left(\sum y\right)^2\right)\right.}}$$

where, r = correlation coefficient, x and y = parameters.

RESULTS AND DISCUSSION

River water quality study is usually required for stabilizing base line conditions, setting quality certain and standards, monitoring of temporal.

Fresh water environment, unlike the marine ones, are subjected to various in the ecological parameters like temperature of water. Temperature is one of the most important among the external factors which influence the aquatic ecology (Huet, 1986). Average water temperature was 23.5°C was similar to that obtained for the river Buriganga (Islam *et al*., 1974) during late winter. Safi *et al*. (1978) observed average temperature 25.8°C of the river Meghna near Daudkandi In the Karnafully estuary the value was 27.52°C (Islam *et al*., 1974). However water temperature in the present investigation showed a narrow range of variation. Water temperature varied from 22.1 to 23.5°C (Table 1).

The maximum transparency was recorded at 52.5±2.05 cm in Station-V (Nirala) and lowest in Station-II (Boyra) was 15.00±0.47 cm indicate a high variation in suspended and dissolved solids in different locations. Where as the average transparency through the river during study was 37.25±3.20 cm (Table 1), similar result was reported by Hossain (1992) from Burigonga River. The water transparency rapidly increased from Station III up to Station VI, which indicate the water contain less suspended solids.

The highest concentration of total suspended solid (TSS) recorded at 123.3 mg L^{-1} in Station-III and the lowest 74.5 mg L^{-1} in Station-VI at the time of observation. The range of total suspended solid was found to be varied from 74.5 to 123.3 mg L^{-1} (Table 1); this value supported the findings of Basher (1989) and Hossain (1992). TSS in the present study increased from Station-II to Station-III shapely and rapidly decreased from Station-IV to Station-V and remains steadily up to Station-VI.

Total dissolved solid varied from 255.0 mg L^{-1} to 305.0 mg L^{-1}. The highest value 305.0 mg L^{-1} was found in the Station-III and the lowest 255.0 mg L^{-1} value in Station-IV (Table 1). Hossain (1992) reported the total solid 52 mg L^{-1} and total dissolved solid 443 mg L^{-1} in Karnophuli River, Chittagong and 540 mg L^{-1} total solid and 450 mg L^{-1} total dissolved solid reported by Basher (1989) in the Bhairab River, Khulna which support the result of present investigation.

Turbidity value in the present study ranged from 16.5 to 21.5 NTU. The highest value 21.5 NTU was recorded from Station-III and lowest value was observed in Station-VI (16.5NTU), which indicates that, the suspended and dissolved solid in the water column were

Table 1: Valve of physical parameters (Mean±SD) of Mouri River

	Station					
Parameters	I	II	III	IV	V	VI
Temperature (°C)	22.40±0.659	22.60±0.639	23.25±2.07	23.45±0.68	23.66±1.85	24.03±1.26
Transparency (cm)	27.60±2.05	32.33±2.05	15.70±0.47	40.66±0.94	52.66±2.08	45.00±2.49
Turbidity (NTU)	19.33±1.5	19.33±0.57	21.03±0.57	17.00±1.00	17.33±0.57	17.33±1.52
TSS (mg L^{-1})	96.30±1.70	88.60±1.15	123.30±2.51	75.30±1.30	77.60±1.17	76.60±1.32
TDS(mg L^{-1})	283.00±10.5	266.00±11.15	330.00±12.45	266.00±10.208	276.00±11.05	280.00±10.20

Table 2: Values of chemical parameters (Mean±SD) of Mouri River water

	Station					
Parameters	I	II	III	IV	V	VI
EC (µS cm^{-1})	169.00±1.12	156.00±1.05	187.00±0.01	180.00±1.02	148.00±1.08	216.00±1.07
Water pH	7.60±0.1	7.86±0.05	7.56±0.25	8.13±0.15	7.86±0015	7.80±0.05
DO (mg L^{-1})	1.30±0.56	1.4±0.85	6.56±0.80	8.10±0.46	7.80±0.95	8.06±0.58
Free CO_2 (mg L^{-1})	28.26±0.78	27.46±1.49	21.76±0.68	31.56±0.605	35.13±0.32	30.16±0.351
Alkalinity (mg L^{-1})	385.00±5.0	355.00±8.66	446.50±15.27	472.30±19.67	584.30±30.50	417.33±16.16
Acidity (mg L^{-1})	164.57±10.48	148.55±2.38	38.50±2.10	94.68±7.89	108.15±2.76	35.50±2.85
Hardness (mg L^{-1})	386.00±5.29	318.88±7.63	372.60±20.52	427.33±54.0	521.33±10.10	370.66±19.08
BOD (mg L^{-1})	21.83±0.76	25.33±0.57	29.90±1.68	18.66±2.08	16.96±1.95	14.93±1.001
COD (mg L^{-1})	355.00±4.61	363.66±3.21	397.00±14.74	326.00±13.85	349.33±5.13	298.66±10.26
Sulphate (mg L^{-1})	47.65±0.63	48.28±0.46	55.17±1.08	56.52±0.76	46.52±1.31	42.90±1.07
Phosphate (mg L^{-1})	7.43±0.185	7.96±0.166	9.84±0.620	10.69±0.66	5.32±0.13	5.35±0.44
Nitrite (mg L^{-1})	1.75±0.06	1.85±0.03	0.95±0.05	0.97±0.01	1.57±0.07	0.57±0.038
Sodium (mg L^{-1})	27.12±0.1	34.20±0.3	26.50±0.52	25.30±0.35	26.03±0.20	16.66±0.46
Potassium (mg L^{-1})	3.13±0.14	6.83±0.11	3.56±0.11	3.60±0.20	3.36±0.152	1.60±0.10
Calcium (mg L^{-1})	92.66±1.52	81.33±3.21	66.33±1.57	71.66±2.51	50.66±1.52	55.66±0.57
Magnesium (mg L^{-1})	55.66±0.57	57.00±2.00	49.33±2.51	49.33±2.51	47.00±1.52	31.66±0.57
Iron (mg L^{-1})	3.66±0.152	3.36±0.152	3.56±0.321	3.08±0.185	3.4±0.429	2.66±0.152

coming from different sewage canal in the river (Table 1). Bilgrami *et al*. (1985) recorded turbidity in Ganga River 394.5 NTU, which is higher than the present result; This may be due to Gangs highly current and sedimentation of nature.

Electrical conductivity in the Rayermahal (Station-I) and Boyra (Station-II) was found to be varied from 159.0 to 180.2 µS cm^{-1} and 150 to 185.0 µS cm^{-1} (Table 2). In general conductivity ranges between 164.0 to 275.0 µS cm^{-1}. In comparison to the conductivity values of different places of Jamuna river (160.0 to 550.0 µS cm^{-1}), Burigonga (160 to 390 µS cm^{-1}); Shitalakhya (170 to 490 µS cm^{-1}); Meghna (64 to 95 µS cm^{-1}) and Padma (136 to 740 µS cm^{-1}) (SPBB, 1998) are supportive to the present results.

The minimum pH value 7.3 found at Station-III and the maximum 8.3 at Station-VI (Table 2) and average through the river 7.7. Decline pH has been reported by Goel *et al*. (1980), Laxminarayana (1965), Pahawa and Mehrotra (1966) and Prasad and Saxena (1980) from different water receive sewages. The present result corroborates similar findings. The pH value in the present investigation showed slightly alkaline condition. The pH remained a buffer condition of the river Mouri. Roy (1955) observed the pH value river Hoogly to be more or less stable with the range of 8.3 to 8.4, which is another example of high buffering capacity and present study supported this statement.

Reduction of dissolved oxygen (DO) as a result of sewage outfall into the river has been reported by Saxena *et al.* (1966) and Bulusu *et al.* (1967). The maximum dissolved oxygen (8.18 mg L^{-1}) was recorded Station-VI and minimum dissolved oxygen (1.10 mg L^{-1}) in Satiation-I and average value was 5.5 mg L^{-1} (Table 2) in the present study. This may be resulted from consumption of oxygen for decomposition of organic matters. Khandaker (1986) recorded the dissolve oxygen in Karnaphuli river 5.1 mg L^{-1} that supported the result of present study. Minimum dissolve oxygen concentration has to be at least 5.00 mg L^{-1} for maintaining aquatic life healthy condition and dissolve oxygen concentration less than 5.00 mg L^{-1} are indicative of pollution (Khandaker, 1986). All through the station except station II and I average dissolve oxygen concentration recorded 7.25 mg L^{-1} that is good enough for aquatic life. In station II and I oxygen concentration was very low (1.15 mg L^{-1}) which indicate the higher level of pollution of this two pints.

Free carbon dioxide in the present study found at the range between 21.00 and 35.5 mg L^{-1}. The maximum free CO_2 (35.5 mg L^{-1}) was recorded Station-V and minimum free CO_2 (21.00 mg L^{-1}) in Satiation-III (Table 2). Bilgrami *et al*. (1985) studied the Physico-Chemical parameter of Ganga River and found free carbon dioxide at 2.34 mg L^{-1} and water quality of the river Betw (India) was observed by Mishra (1991) and his found free carbon dioxide at 3.03 mg L^{-1} that is much lower than the result of

present investigation. Respiration by zooplankton and other organisms may be one of the probable cause of very high concentration of free carbon dioxide in present investigation.

Alkalinity in unpolluted river water of Ganga was found 171.2 to 235.5 mg L^{-1} (Shastree *et al*., 1991). In the present study the maximum value exceeded 500 mg L^{-1} in Station-V (Nirala-west), which indicates the water is highly polluted in this point. The highest alkalinity (570 mg L^{-1}) was recorded in Station-III and the lowest (354 mg L^{-1}) in Station-VI (Table 2), which was much higher than the values reported from other habitats (Shastree *et al*., 1991). Alkalinity in the present study started increased from station-II to station-V and decreased at station-VI.

Acidity in the present study found to vary from 32.40 and 171.23 mg L^{-1}. The maximum acidity was recorded (171.23 mg L^{-1}) in Station-I and minimum acidity (32.40 mg L^{-1}) in Satiation-VI (Table 2). Acidity started to decrease from station I up to the station III and increased from station-IV it station-V, at station VI it again decreased.

Waters become hard primarily due to excessive presence of bicarbonate, chloride and dissolved sulfate in water primarily. The highest level of hardness 280 mg L^{-1} was recorded from the Station-I and lowest 34.45 mg L^{-1} from the Station-VI and in general it was found to vary between 310 and 529 ppm (Table 2). Similar result was reported by Desia (1982). Hardness in the present study started increased from station-II to station-V and decreased at station-VI

Biochemical Oxygen Demand (BOD) varied from 13.5 to 33.5 mg L^{-1} in the Mouri River. The highest BOD level was recorded (33.5 mg L^{-1}) in Station-III and the lowest as (13.5 mg L^{-1}) in the Station-VI (Table 2), which location receive the highest and lowest amount of sewages, respectively. River water contains BOD more than 10 mg L^{-1} is considered to be moderately and more than 20 mg L^{-1} as to be highly polluted water (Paul, 1999), according this range Mouri river considered as polluted. The present study showed sharply increased of BOD in station-I to III and from station-IV it stated to decrease up to station-VI.

Chemical Oxygen Demand (COD) level varied from 293 to 380 mg L^{-1} in the Mouri River. The highest value was recorded (380 mg L^{-1}) as in Station-III and the lowest (293 mg L^{-1}) in Station-VI (Table 2) This result corroborated with the result of Das *et al*. (1990) who recorded 373 to 375 mg L^{-1} in Indian river of Northern prodesh and Desia (1982) recorded 300 mg L^{-1} in Kankari lake, India.

Phosphate has been found trace to 1.00 mg L^{-1} in many river of Indian polluted area (David, 1963; Pahawa and Mehrotra, 1966) and Ganga river. But in present study the phosphate was found to very 5.00 to 10.00 mg L^{-1}. The minimum concentration was 5.39 mg L^{-1} in the Station-IV and maximum concentration was 10.925 mg L^{-1} in the Station-V (Table 2), which indicates the moderate to high level of pollution in the Mouri River. This result is confirmed with Trivery and Khatavkar (1986) and Desia (1982).

Sulphate in the present study varied from 42.46 to 57.36 mg L^{-1}. The highest concentration as 57.36±1.25 mg L^{-1} was at station-IV and lowest as 42.46±0.59 mg L^{-1} at station-VI was recorded. This value of sulphate is much higher than the finding of Mishra (1991). The possible causes of the higher value of sulphate may be due to the used of detergent and soap by the neighbors and the city dwellers.

Nitrite showed the maximum concentration as 1.85 mg L^{-1} in Station-II, it was found to very from 0.57 to 1.85 mg L^{-1} (Table 2). Laxminarayana (1965) reported 2.6 mg L^{-1} nitrite in polluted stretch of Moosi, which is near similar to the present study.

Sodium concentration was fluctuated between 16.00 to 34.70 mg L^{-1}. The highest and the lowest value 34.7 and 16 mg L^{-1} were recorded in Station-II and Station-VI, respectively (Table 2). Trivery and Khatavker (1986) reported the concentration of sodium in Krishana river, India ranged 10 to 25 mg L^{-1} which supported the findings of present investigation.

Highest value of potassium concentration was recorded in station-II (6.9 mg L^{-1}) and lowest in Station-VI (1.5 mg L^{-1}) in the Mouri River (Table 2). Trivery and Khatavker (1986) reported the concentration of potassium in Krishana river, India ranged 01 to 02 mg L^{-1} which was less than the value of present investigation. The highest and lowest value of calcium was obtained from Station I and V were 92.66 and 50.66 mg L^{-1}, respectively (Table 2). Trivery and Khatavker (1986) reported the concentration of calcium in Krishana river, India ranged 17 to 44 mg L^{-1} which was much lower than the result of present investigation.

Magnesium concentration was found to be highest as 59.66 mg L^{-1} and the lowest as 31.66 mg L^{-1} in Station I and VI, respectively (Table 2). Trivery and Khatavker (1986) reported the concentration of magnesium in Krishana river, India ranged 7.32 to 18 mg L^{-1} which was lower than the result of present investigation but Desia (1982) found concentration of magnesium 70 mg L^{-1} in Kankari lake, India which supported the result of present study.

Highest and lowest concentration of iron was recorded in the Station III (3.7 mg L^{-1}) and station VI (2.6 mg L^{-1}), respectively (Table 2). Ouseph (1992) observed the highest concentration of iron 1.00 mg L^{-1} in Cochin estuary, India where as Mehedi *et al.* (1999) recoded the highest concentration of iron in the ship breaking area of Karnophuli 65 to 67 mg L^{-1}.

Correlation among the physical and chemical water quality parameters: A positive correlation between water temperature and pH, hardness, total alkalinity, DO, free CO_2 and Sulphate was found in the present study (Table 3). These results are similar to Nair *et al.* (1980), Jana (1979) and Singh (1986).

Phosphate showed positive relation with BOD, COD, alkalinity and hardness (Table 4). The results of present investigation have contradictory with Singh (1986) who described the inverse relation among them.

Transparency in the present investigation showed a significant negative correlation with phosphate, Nitrite, TSS, TDS and Turbidity and positive correlation with Hardness, DO, Free carbon dioxide and Sulphate (Table 4). These results are similar to Nair *et al.* (1980). However, the significant relationships of transparency, phosphate and Sulphate as described by Nair *et al.* (1980) and Singh (1986) were not found in the present investigation, (PO_4: r = 0.4986, t = 2.105; SO_4: r = 0.472, t = 1.965).

The pH of the Mouri river water showed positive relationship with hardness, total alkalinity, sulfate, free carbon dioxide and phosphate (Table 4). However it showed insignificant inverse relation with Nitrite, BOD, COD (r<0.5). A significant relationship between pH and DO (Shastree *et al.*, 1991), hardness (Singh, 1986), Sulphate (Nair *et al.*, 1980) and positive relation with DO was not found in the present investigation.

Jana (1979), Singh (1986), Arce and Boyd (1980) and Nair *et al.* (1980) described positive relation of hardness with water temperature, transparency, total alkalinity and negative relationship with Turbidity, conductivity. The similar results were observer in the present investigation. However significant inverse relationship between hardness and DO reported by Nair *et al.* (1980) was not found in the present study.

Total alkalinity in the present study showed positive relationship with DO, Free carbon dioxide and Sulphate and negative relationship with Nitrite, Phosphate, Calcium, Sodium, Potassium and Magnesium (Table 3).

Dissolved oxygen (DO) showed significant negative relationship with Nitrite, Electrical conductivity, Turbidity, BOD, COD, Calcium, Sodium, Potassium and Magnesium in the present investigation (Table 4). Similar findings were reported by Munawar (1970). However Ganipati (1943), Zafar (1964) and Nair *et al.* (1980) reported positive relationship between DO and nitrite, which was not found in present investigation.

Free Carbon dioxide showed only positive correlation with Nitrite and negative relationship with Sulphate, Phosphate, Calcium, Magnesium, Potassium, Sodium and Iron. However none of the above relationship were found to be significant (r<0.5 and t<2.228). Nitrite in the present investigation showed significant positive

Table 3: The correlation coefficient (r) and t-value among different physical water quality parameters of Mouri river

	Water Temp.		Transparency		TSS		TDS		Turbidity	
Parameters	r	t	r	t	r	t	r	t	r	t
Water temperature	1		-		-		-		-	
Transparency	-0.529	2.238	1		-		-		-	
TSS	-0.318	0.982	-0.929	19.321	1		-		-	
TDS	0.131	0.521	-0.711	15.21	0.881	8.21	1		-	
Turbidity	-0.465	0.109	-0.93	19.53	0.975	9.325	0.795	16.32	1	
pH	0.284	1.251	0.689	5.282	-0.891	8.201	-0.78	6.952	-0.81	17.325
Alkalinity	0.062	0.085	0.554	6.329	-0.262	0.375	-0.349	2.195	-0.37	2.203
Acidity	-0.791	8.528	0.025	0.012	-0.178	0.125	0.554	2.292	-0.54	2.301
Hardness	0.155	0.128	0.628	4.821	-0.378	0.825	-0.381	2.021	-0.83	18.31
Free CO_2	0.369	0.825	0.955	19.38	0.038	0.0012	-0.219	1.956	-0.92	18.58
Dissolved oxygen	0.938	12.62	0.462	2.201	-0.284	1.562	-0.608	11.05	-0.43	2.23
BOD	-0.588	2.932	-0.9	18.37	0.547	12.298	0.886	18.32	0.941	18.27
COD	-0.524	2.312	-0.74	13.29	0.506	12.018	0.845	16.33	0.874	18.235
Sulphate	0.16	0.253	0.477	1.892	0.406	2.205	0.406	2.205	0.328	2.123
Phosphate	0.368	0.456	-0.59	2.45	0.425	2.208	0.425	2.208	0.337	2.132
Nitrite	-0.791	12.21	-0.06	0.125	0.032	0.012	0.032	0.013	0.177	0.1205
Iron	-0.646	10.2	-0.57	3.393	0.508	2.231	-0.714	15.2.8	0.675	13.12
Sodium	0.85	17.82	-0.35	2.005	0.56	2.352	-0.772	16.23	0.408	2.189
Calcium	-0.897	17.82	-0.57	3.305	0.288	1.015	-0.292	0.785	0.376	2.102
Magnesium	-0.896	18.98	-0.46	2.018	0.35	1.085	-0.172	0.569	0.441	2.185
Potassium	-0.758	13.21	-0.25	0.012	0.135	0.129	-0.625	14.35	0.366	1.896
Electrical conductivity	0.546	2.392	-0.193	0.021	-0.321	0.13	-0.234	1.205	0.152	0.289

Table value of t at 5% level of significance at 10 degree of freedom is 2.228 Significant -ve r = 37 times and Significance +ve r = 22 times

Table 4: The correlation coefficient (r) and t-value among different chemical water quality parameters of Mouri river

Parameters	pH r t	Alkalinity r t	Acidity r t	Hardness r t
pH	1	-	-	-
Alkalinity	0.256 1.798	1	-	-
Acidity	-0.009 0.015	-0.275 1.253	1	-
Hardness	0.264 1.785	-0.239 1.109	-0.239 1.11	1
Free CO_2	0.657 4.201	0.586 2.312	0.116 0.548	0.729 18.231
Dissolved Oxygen	0.443 2.191	0.711 15.321	-0.782 15.998	0.561 2.935
BOD	-0.582 2.229	-0.389 2.012	0.0562 0.298	-0.507 2.789
COD	-0.647 3.201	-0.062 0.025	-0.115 0.592	-0.651 8.239
Sulphate	0.208 1.12	0.951 17.205	-0.115 2.285	0.0263 0.0125
Phosphate	0.0989 0.0201	0.94 17.012	-0.545 2.283	0.249 1.998
Nitrite	-0.764 14.321	-0.12 0.984	0.917 17.29	0.0172 0.0257
Iron	-0.678 13.18	-0.029 0.018	0.521 2.229	0.04193 0.0832
Sodium	-0.207 0.125	-0.247 0.185	0.695 12.205	-0.224 0.593
Calcium	-0.279 0.128	-0.7305 14.258	0.704 13.259	-0.381 0.925
Magnesium	-0.21 0.528	-0.25 1.125	0.772 14.293	0.925 0.917
Potassium	-0.081 0.029	0.347 1.896	0.554 6.28	17.29 0.521
Electrical conductivity	-0.0192 0.025	-0.347 1.897	0.556 2.289	2.229 -0.279

Parameters	Free CO_2 r t	DO r t	BOD r t	COD r t	Sulphate r t	Phosphate r t	Nitrite r t	Iron r t	Sodium r t
Free CO_2	1	-	-	-	-	-	-	-	-
Dissolved Oxygen	0.349 1.598	1	-	-	-	-	-	-	-
BOD	-0.875 16.321	-0.836 18.325	1	-	-	-	-	-	-
COD	-0.651 14.321	-0.8.5 13.035	0.91 18.356	1	-	-	-	-	-
Sulphate	-0.369 1.298	0.165 0.558	0.529 3.1254	0.478 2.201	1	-	-	-	-
Phosphate	-0.497 2.207	-0.497 2.02	0.572 3.489	0.405 2.202	0.94 17.328	1	-	-	-
Nitrite	0.197 0.565	-0.774 14.372	0.267 1.893	0.445 2.205	-0.121 0.584	-0.132 0.5109	1	-	-
Iron	-0.395 2.105	-0.586 2.984	0.673 12.251	-0.883 17.32	0.282 0.598	0.221 0.631	0.7001 14.05	1	-
Sodium	-0.228 1.526	-0.678 8.325	0.622 10.824	0.669 5.324	0.3188 0.789	0.323 0.739	0.323 0.839	0.66 10.235	1
Calcium	-0.394 0.897	-0.853 14.367	0.447 2.201	0.332 1.245	0.192 0.987	0.406 0.795	0.552 2.32	0.521 2.291	0.512 2.31
Magnesium	-0.25 1.784	-0.727 13.254	0.647 9.875	0.0689 12.146	0.435 1.478	0.452 0.821	0.882 10.245	0.799 14.201	0.923 17.45
Potassium	-0.213 1.495	-0.609 8.201	0.5479 2.998	0.509 2.229	0.234 0.586	0.272 0.521	0.234 0.512	0.799 14.125	0.933 15.264
Electrical conductivity	-0.257 0.228	-0.609 9.356	0.547 10.245	0.5006 2.23	0.234 1.125	0.276 0.218	-0.756 11.32	-0.714 8.125	-0.772 10.256

Table value of t at 5% level of significance at 10 degree of freedom is 2.228 Significant -ve r = 57 times and significance +ve r = 72 times

relationship with Calcium, Magnesium, Potassium, Sodium and Iron. It showed negative relationship with Sulphate and Phosphate (Table 4). Phosphate showed significant positive relation with sulphate. Sulphate in the present investigation showed positive relation with all parameters, except total alkalinity, but none of them is significant which is similar to Nair *et al.* (1980).

Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) showed strongly negative relationship with DO in the present study (Table 3) and which supported by Gupta and Mahrota (1986).

The present study revealed that the physico chemical water quality of the river Mouri is not reasonable. The dissolve oxygen, BOD, hardness, phosphate and nitrite used in the study showed that the quality of water is not now in safe limit (EQS, 1991) and no longer good to support micro and macro flora and fauna, but the situation is alarming and degradation is in continuous process, therefore immediate action is required for its better management.

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