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Determination of Seasonal Variation in Various Physico - Chemical Parameters for Machna River Water in District - Betul (M. P.)

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Abstract: ***Water quality has become a global concern due to increasing population and developmental activities that had over exploit and polluted the water resources available to us. The present study was aimed to assess the quality of Machna River in Betul city (M. P.) with respect to the physico - chemical parameters including Temperature, Electrical Conductivity (EC), pH, Total Alkalinity (TA), Total Hardness (TH), Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Chloride and Nitrate. The results were evaluated and compared with two water quality standards WHO and BIS. From the obtained data, the correlation coefficient (r) was also established to assess the overall river water quality status. On the basis of present study, it was revealed that, during the study period the Machna River water quality was good and suitable for domestic and irrigation purposes.***

Keywords: Physico - Chemical Parameters, Correlation - coefficient (r), Water Quality Standards, Machna River, Betul City.

1. Introduction

The most vital resource for life on the earth is water. There cannot be life without fresh water which is only 2.7 percent of total water on earth. The issues of water are becoming increasingly important to environment particularly with respect to human health and their food. Several towns, cities and communities have disappeared due to the shortage of water and climatic changes. Millions of people all over the world, particularly in the developing countries are losing their lives every year from water borne diseases. Water quality assessment has become an important exercise to evaluate the nature and extent of pollution in order to take appropriate control measures. The water of Machna River is used for domestic and irrigation purposes. Due to the urbanization, sewage discharge, agricultural runoff and construction of housing colonies, a major part of river water is greatly affected. The present study was aimed to assess the quality of Machna River water for its domestic and irrigation purposes.

2. Material and Methods

Betul, a fast growing city, is one of the district places of state Madhya Pradesh and situated about 192 kms South - West of capital city Bhopal. Presently, about 67% of the population of this city is receiving domestic water from Machna River, flowing in the middle of the city and additional water requirement is being made available from dams, wells and bore wells by municipal corporation, Betul. Present study was undertaken to evaluate the direct impact on water quality of Machna river water due to increasing developing activities.

The Machna river samples were collected from six main sampling stations namely S_1, S_2, S_3, S_4, S_5 and S_6 in between the months of May.2020 to Apr.2021 on monthly basis. The sampling points were chosen considering the location of nearby villages, bathing zone area, domestic and agricultural and industrial wastes which joins the river water and are responsible for pollution load in the river water. Samples were collected in acid clean one liter polyethylene bottles in the morning hours in between 7.00 AM to 9.00 AM. Some of the studied parameters were recorded at the sampling stations whereas the analysis of other physico - chemical parameters followed by the method prescribed by APHA (1995).

3. Results and Discussion

The physico - chemical parameters such as Temperature, pH, Turbidity, Electrical Conductance, Ca - Hardness, Mg - Hardness, Total Hardness, Total Dissolve Solids, Total Alkalinity, Chloride, Nitrate, Dissolve Oxygen, Biochemical Oxygen Demand and Chemical Oxygen Demand were analyzed for the water samples collected from the Machna river. All parameters with their Maximum Value, Minimum Value, Average were calculated. Correlation - coefficient (r) among them were also established as shown in the Table 1, 2 and 3 respectively.

Temperature - Temperature is considered as to be one of the most important factors in an aquatic ecosystem. Water temperature is an important factor for aquatic flora. It depends on solar radiation, evaporation, wind, length of the day, relative humidity and cloud cover. The most suitable temperature for plant growth is 20°C - 35°C. Temperature over 30°C may cause regression in plant growth and decay in plant. During the present study, the range of river water temperature has been found to vary between **15**°C to 35°C with average value 24°C. The minimum value of water temperature was recorded in the month of Feb. and the maximum in the month of May. It showed positive correlation with turbidity.

Turbidity – Turbidity is the cloudiness of water caused by a variety of particles and is another key parameter in the analysis of quality of drinking water. It is also related to the

content of diseases causing organisms in water, which may come from soil runoff. Turbidity indicates the muddiness of water therefore measure the extent to which light absorbed or scattered by fine suspended and colloidal solids and is a measure of resistance of water to the passage of light through it. It can be removed from water by filtration, sedimentation and clarification in water treatment plant process. In the present study, the turbidity in the water of Machna river was recorded ranges from 2.6 to 4.1 NTU with average value 3.4 NTU. The maximum value of turbidity was recorded in the month of Aug. because of soil runoff during monsoon season. The minimum value of turbidity was recorded during summer season in the month of May. It shows negative correlation with all studied parameters except temperature.

Electrical conductivity (EC) - Water capability to transmit electric current is known as electrical conductivity and serves as tool to assess the purity of water. This ability depends on the presence of ions, their total concentration, mobility, valence, relative concentrations and temperature of measurement. The electrical conductivity ranged from 261 to 278 µmhos/cm with average value **269** µmhos/cm. The minimum value of electrical conductivity was reported in the month of May due to the low amount of water in the river and maximum was reported during monsoon season in the month of Aug. because of water dilution by rain water. It shows negative correlation with temperature and turbidity.

pH - pH is defined as the intensity of the acidic or basic character of a solution at a given temperature. pH is negative logarithm of hydrogen ion concentration. pH= - log [H+]. The pH of water is important for the biotic communities as most of the plant and animal species can survive in narrow range of pH from slightly acidic to slightly alkaline condition. In study period from May 2020 to Apr.2021, pH value ranged from 7.1 to 8.2 with average value 7.6. The minimum pH was reported in the month of May due to the low water levels and concentration of nutrients in water and maximum was recorded in the month of Aug. due to the dilution of water by addition of rain water. It shows negative correlation with temperature and tur.

Total Alkalinity (TA) - The total alkalinity of river water is primarily a function of carbonate, hydroxide content and also includes the contributions from borates, phosphates, silicates and other bases. Alkalinity is a measure of capacity of water to neutralize a strong acid. The alkalinity in the water samples ranged from 147 to 169 mg/l with average value 158.7 mg/l. The minimum value was recorded in the month of Apr. due to the dilution of river water through rain. The maximum value of alkalinity was recorded in Aug. due to high nutrients in water. It shows negative correlation with temperature and turbidity.

Calcium Hardness (Ca - H) - Calcium is most abundant ions in fresh water and is important in shell construction, bone building and plant precipitation of lime. The analysis of calcium hardness found a range between 48 to 72 mg/l with average value 55 mg/l. The minimum value of calcium hardness in river water was recorded in the month of May due to calcium absorbed by the large number of organisms for shell construction, bone building and plant precipitation of lime. The maximum value of calcium hardness was recorded in water samples in the month of Jul. due to the addition of domestic waste along with rain water and responsible for the increase in amount of calcium. It shows positive correlation with all studied parameters except temperature and turbidity.

Magnesium Hardness (Mg - H) - Magnesium is often associated with calcium in all kinds of waters, but its concentration remains generally lower than the calcium. Magnesium is essential for chlorophyll growth and acts as a limiting factor for the growth of phytoplankton. The amount of magnesium hardness was recorded in the water samples range between 41 to 59 mg/l with average value 53.5 mg/l. The minimum value of magnesium hardness was recorded in the month of May due to the magnesium essentiality for chlorophyll bearing plant for photosynthesis. The maximum value of magnesium hardness in the water samples was found in the Month of Jul. during monsoon season as it is associated with calcium in water and, calcium was found higher in concentration during monsoon season. It shows positive correlation with all studied parameters except temperature and turbidity.

Total hardness (TH) - The total hardness of water is not a specific constituent but is a variable and complex mixture of cations and anions. Principally the water hardness are changed by ions such as calcium and magnesium. The total hardness from the water samples at Machna river ranged between 89 to 131 mg/l with average value 116.5 mg/l. The minimum value of total hardness was recorded in the month of May due to low concentration of calcium and magnesium. The maximum value of total hardness in the water was recorded in the month of Aug. due to presence of high content of calcium and magnesium in addition to sulphate and nitrate during rainy season. It shows positive correlation with all studied parameters except temperature and turbidity.

Total dissolved solids (TDS) - Solids refers to the suspended and dissolved matter in water. They are very useful parameters describing the chemical constituents of the water and can be considered as edaphically relation that contributes to productivity within the water body. The total dissolved solids in the sampled water ranged from the 138 to 168 mg/l with average value 154 mg/l. The minimum value of TDS was reported in the month of May and maximum was reported in Aug. due to the addition of organic matter and solid waste into the river water. It shows negative correlation with temperature and turbidity.

Dissolved Oxygen (DO) - The higher value of dissolved oxygen indicates good aquatic life. The amount of dissolved oxygen of Machna river water samples ranged between 7.9 to 9.1mg/l with average value 8.5 mg/l. The lowest dissolved recorded in the month of May due to the high temperature and addition of domestic sewage and other waste which can be responsible for low value of dissolved oxygen. The maximum value of DO was recorded in the month of Aug. due to the turbulence of water facilitating the diffusion of atmospheric oxygen and the increased solubility of oxygen at lower temperature. It shows positive correlation with all studied parameters except temperature and turbidity.

Biochemical Oxygen Demand (BOD) - The biochemical oxygen demand may be defined as the oxygen required for the microorganism to performed biological decomposition of dissolved solids or organic matter in the wastewater under aerobic conditions. The biochemical oxygen demand reported from water samples of Machna river was ranged between 12.5 to 14.8 mg/l with average value 13.6 mg/l. The highest demand of oxygen in the water was recorded in the month of Aug. due to the possible addition of high amount of addition of organic waste in river through rain water from slum area and other human activities which also be responsible for the increase in BOD. The lowest demand was recorded in the month of May due to less vegetation. It shows negative correlation with turbidity.

Chemical Oxygen Demand (COD) – The chemical oxygen demand is a measure of both the biologically oxidizable and chemically inert organic matters. COD values are generally higher than COD values. It indicates toxic conditions and the presence of biologically resistant organic substances. In the present study, The COD values found in the range of 12.5 mg/l to 15.6 mg/l with average value 9.8 mg/l. The minimum value of COD was recorded in the month of May due to the less amount and high evaporation rate of water from river and found maximum in the month of Aug. due to the addition of rain water into the river water. . It shows negative correlation with temperature and turbidity.

Chloride (Cl^{-}) - The chloride in drinking water originates from natural sources, sewage and industrial effluents, urban runoff containing de - icing salt and saline intrusion. The chloride concentration in Machna river water was noticed between 34 to 42 mg/l with an average value of 37.5 mg/l. The minimum value of chloride was determined in the month of May due to the evaporation of water by Sun and lack of water in river during summer and maximum value of chloride was reported in the month of Aug. due to frequent run - off loaded with contaminated water from the surrounding. It shows negative correlation with temperature and turbidity and all other studied parameters shown positive correlation with chlorides.

Nitrate (NO_3^{3-}) - Nitrates are contributes to freshwater through discharge of sewage and industrial wastes and run off from agricultural fields. The highest amount of nitrate concentration was known to support the formation of blooms. The amount of nitrate recorded in the water of Machna river ranged from 41 to 58 mg/l with average value 52 mg/l. The minimum value of nitrate in water was recorded during summer season in the month of May due to the utilization by plankton and aquatic plants and maximum was in the month of Aug. because of high vegetation during Monsoon which supported the growth of plankton. It shows positive correlation with all studied parameters except temperature and turbidity.

Conclusion

In the present study, it has been observed that the water quality in the study area of the Machna river for domestic as well as irrigation purposes at district Betul (M. P.) is reasonably good and does not show any alarming level of pollutants. However, it need some degree of treatment before supply and consumption and to improve the water quality of river, local government and public authority should be aware about the water pollution and adopts some necessary preventive measures for controlling the river water pollution.

Table 1: Standard Permissible Limit of WHO Standards and BIS Standards (IS 10500: 2012)

S. No.	Parameters	Unit	Standard Permissible Limit	
			WHO Standards	BIS Standards IS 10500: 2012
1.	Temperature	^{O}C	-	-
2.	Turbidity	NTU	-	-
3.	Ele. Conductivity	µmhos/cm	-	-
5.	pH	-	7.5 – 8.5	6.5 – 8.5
4.	Total Alkalinity	mg/l	120	200 - 600
6.	Ca - Hardness	mg/l	-	-
7.	Mg - Hardness	mg/l	-	-
8.	Total Hardness	mg/l	1000	200 - 600
9.	Total dissolved Solids	mg/l	1000	500 - 2000
10.	DO	mg/l	-	>5
11.	BOD	mg/l	-	-
12.	COD	mg/l	-	-
13.	Chloride	mg/l	250	250 - 1000
14.	Nitrate	mg/l	5.0	45

Table 2: Range of variation as Maximum, Minimum and Average values of studied water quality parameters of the Machna river water during May.2020 to Apr.2021

S. No.	Parameters	Summer Season		Mansoon Season		Winter Season		Average
		Min.	Max.	Min.	Max.	Min.	Max.	
1	Temp.	27	35 (May)	23	26	15 (Feb)	18	24
2	Tur.	3.1	2.6 (May)	3.8	4.1 (Aug)	3.2	3.6	3.425
3	Ele. Cond.	261 (May)	263	269	278 (Aug)	270	274	269
4	pH	7.1 (May)	7.3	7.8	8.2 (Aug)	7.6	7.8	7.625
5	TA	147 (Apr)	152	161	169 (Aug)	163	159	158.75
6	Ca - H	48 (May)	54	64	72 (Jul)	65	69	63
7	Mg - H	41 (May)	48	53	59 (Jul)	55	58	53.5
8	TH	89 (May)	102	117	131 (Aug)	120	127	116.5
9	TDS	138 (May)	145	150	168 (Aug)	159	162	154
10	DO	7.9 (May)	8.2	8.8	9.1 (Aug)	8.4	8.6	8.5
11	BOD	12.5 (May)	12.8	14.8	15.6 (Aug)	12.9	13.0	13.375
12	COD	9.6 (May)	9.7	10.1	10.4 (Aug)	9.8	9.9	9.875
13	Chloride	34 (May)	36	38	42 (Aug)	37	39	37.5
14	Nitrate	41 (May)	45	51	58 (Jul)	54	58	52

Table 3: Correlation coefficient (r) among various studied parameters of Machna River Water During May.2020 to Apr.2021

	Temp	Tur	pH	Ele. Cond.	Ca - H	Mg - H	TH	TA	TDS	DO	BOD	COD	Cl^-	No_3^{3-}
Temp	1.00													
Tur	0.39	1.00												
pH	- 0.47	- 0.78	1.00											
Ele. Con.	- 0.30	- 0.88	0.94	1.00										
Ca - H	- 0.47	- 0.98	0.86	0.89	1.00									
Mg - H	- 0.62	- 0.80	0.98	0.92	0.87	1.00								
TH	- 0.63	- 0.71	0.98	0.86	0.82	0.99	1.00							
TA	- 0.62	- 0.77	0.98	0.90	0.85	1.00	1.00	1.00						
TDS	- 0.53	- 0.70	0.96	0.82	0.83	0.93	0.96	0.95	1.00					
DO	- 0.16	- 0.88	0.83	0.97	0.84	0.81	0.72	0.78	0.66	1.00				
BOD	0.11	- 0.83	0.59	0.83	0.73	0.55	0.43	0.51	0.40	0.93	1.00			
COD	- 0.03	- 0.88	0.78	0.94	0.83	0.74	0.65	0.70	0.62	0.99	0.96	1.00		
Cl^-	- 0.14	- 0.78	0.93	0.96	0.82	0.86	0.84	0.86	0.84	0.92	0.78	0.92	1.00	
No_3^{3-}	- 0.68	- 0.66	0.95	0.82	0.77	0.97	1.00	0.99	0.95	0.67	0.36	0.58	0.79	1.00

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