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Studies on Physiochemical Parameters to Assess the Water Quality of Vena River for Drinking Purposes, Hingna Region, Nagpur District, Maharashtra, India

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ABSTRACT

The Vena river rises near Vena dam (off Amaravati Rd) and then flows towards the Wardha river through Hingna taluka, near Butibori. It is the water source for about ten villages and yet its water is polluted. This is mainly due to the discharge of untreated industrial effluents and sewage in it as Hingna is an industrial suburb of Nagpur city with industries operating from Maharashtra Industrial Development Corporation areas. The present study has been made to analyze the quality of the Vena river water in the winter season. Representative samples were taken from four locations along the course of the river. Various parameters like pH, Total Dissolved Solids, Alkalinity, Dissolved Oxygen, Chemical Oxygen Demand, BOD, EC, nitrate, chloride, sulphate, fluoride, etc. indicate quality parameters of river water. From the above parameters analyzed, it was concluded that the Vena river water is of good quality and satisfies the requirement for use of various purposes like domestic, agricultural, industrial, etc. All physicochemical parameters were compared with the Bureau of Indian Standards (BIS) and National River Water Quality standards.

Keywords: Vena River, Representative Samples, Total Dissolved Solids, Dissolved Oxygen, Chemical Oxygen Demand, BOD.

INTRODUCTION

All living things need water for their survival. Water covers more than 70% of the Earth's surface. Less than 1% of that resource is available as freshwater – and this is not evenly

distributed throughout the world. Water plays a significant role in maintaining human health and welfare. Clean drinking water is now recognized as a fundamental right of human beings. Around 780 million people do not have access to clean and safe water and around 2.5 billion people do not have proper sanitation. In today's world, water used in households is commonly defined as domestic water. This water is safely consumed as drinking water and used for other domestic purposes. Water quality and its suitability for domestic use are determined by its taste, odor, color, and concentration of organic and inorganic materials. Contaminants in the water can affect the water quality and consequently human health. The potential sources of water contamination are geological conditions, industrial and agricultural activities, and water treatment plants. These contaminants are further categorized as microorganisms, inorganics, organics, radionuclides, and disinfectants[1].

The present paper reports the results of an analysis of the Vena river by reporting physicochemical parameters, which will aid in removing contamination of water in a future study. All physiological and metabolic activities and life processes of aquatic organisms are generally influenced by such polluted waste and hence its essential to study physicochemical parameters of water. The river water is analyzed for the water quality parameters such as pH, conductivity, Turbidity, and TDS and Temperature. The effluent samples were collected from four different sites in the winter season.

STUDY AREA

The Vena River is located at 78.9638 longitudes and 21.0772 latitudes in Nagpur district of Maharashtra. The area of the Vena river is 200 square kilometers approximately. Red and laterite soils are found here which are quite rich in minerals. The area near Hingna is rich in many materials and hence an industrial plant is situated in Hingna. The Hingna taluka is situated in a green region, which adds to the natural beauty of the city. Hingna is now moving towards a mega industrial suburb due to urban modernization.

SELECTION OF SAMPLING POINTS

The criteria for collecting the representative sample are based on the location, population, density, geological activities, and industrial areas. The area is famous for its religious activities and cultural programs so that the river is polluted by throwing herbs, plastic bowls, and ashes in the river. In addition, various rituals in Hindu festivals make it mandatory for adding pollutants to the river.

Moreover, immersing statues of deities in the river is the regular practice for several major festivals. The painters use paint and some decorative ornaments on the sculpture that are not biodegradable so that they harm the river ecology, which in turn jeopardizes the vegetation and animal life. This increases in the months starting from September to October, and more and more people submerge the sculptures in the river. According to the official data from Gram Panchyat in Hingna, in 2019, there were 127 pujas and around 543 Visarjans in Vena River alone. Most of them, are Plaster of Paris idols and it takes several months to

dissolve, poisoning the waters in the process. Plastic packets, Thermacol pieces, puja material like mostly Marigold flowers and foodstuff offerings, some decorative pieces, plastic materials like sheets, bags, etc are all thrown into the river, and these cause the pollution of the river water.

SAMPLING POINTS

The samples were collected from the sampling sites, as follows, as the sample should be a representative sample:

- From one side of the riverbank
- 2-3 meters away from the bank in a straight line toward the middle of the river
- From 2-3 meters away from another side of the riverbank
- From the other side of the riverbank

These are the locations for site 1. From site 1, the second site was at a distance of about 8 meters. So, from each site 4 samples were collected, and a total of 16 samples was collected[2].

PARAMETERS ANALYSED

Colour and Odour

The water samples were generally found to be colored due to the presence of some colloidal particles, inorganic impurity, aquatic minerals, and submerged vegetation. The water samples collected in autumn season towards winter season are usually found to be colorless, odorless, and clear[3].

Temperature

The temperature of the water sample, at a selected depth was directly measured with the thermometer dipped within the water body. After a particular time has passed, the thermometer gave the precise temperature of the water. The river bank and the middle side of the river show some change within the temperature value.

pH Value

pH value is the logarithm of reciprocal of cation activity in moles per liter. In water solution, variations in pH value from 7 are mainly because of hydrolysis of salts of strong bases and weak acids or the other way around. Dissolved gases like greenhouse gas, hydrogen sulphide, and ammonia also affect the pH value of water. The pH range of natural water is usually between 6 and eight. In the case of alkaline waters, pH is also over 9 while for acidic waters, the pH is 4 or perhaps less than 4. Industrial wastes are also strongly acidic or basic

and their effect on the pH value of receiving water depends on the buffering capacity of water[3]. The pH value obtained within the laboratory might not be identified as that of water at the time of collection of samples because of loss or absorption of gases, reactions with sediments, hydrolysis, and oxidation or reduction happening within the sample bottle.

Electrical Conductivity

Pure water is not a good conductor of electricity. Ordinary H_2O in equilibrium with air containing greenhouse gases includes a conductivity of about 10×10^{-6} W-1*m-1 (20 ds/m). Because the electrical current is transported by ions in solution, the conductivity increases as the concentration of ions increases[4].

Turbidity

Turbidity is a very important indicator of the number of suspended sediments in water, which may have many negative effects on aquatic life. The suspended sediments that cause turbidity can block light to aquatic plants, smother aquatic organisms, and carry contaminants and pathogens, like lead, mercury, and bacteria[4].

Total Dissolved Solids

Total Dissolved Solids (TDS), indicate the nature of the salinity of the water. A standard range of TDS is as follows:

Table 1[5]

TDS Range	Description
0-60	Soft
61-120	Moderately hard
121-180	Hard
>180	Very hard

Hardness of Water

The hardness of water is objectionable from the perspective of water use for laundry and domestic purposes since it consumes an outsized quantity of soap. In the present investigation, hardness varied from 209 to 272 mg/l.

Table 2[5]

PARAMETERS	ISI (1983)		WHO (1984)		ICMR		BIS	
	HDL	MPL	HDL	MPL	HDL	MPL	HDL	MPL
pH	6.5-8.5	……..	7.0-8.5	6.5 -9.5	7.0 -8.5	6.5-9.2	7.0-8.3	8.5-9.0
TDS	500	1000	……..	……	500	1500	500	2000
TH	300	600	200	600	300	600	200	600
Turbidity	5	10	5	10	……..	……..	5	10

Abbreviations: HDL- Highest desirable level
MPL- Maximum permissible level
ICMR- Indian Council of Medical research
WHO- World health organization
BIS- Bureau of Indian standard
ISI- Indian Standard Institute

Dissolved Oxygen

Oxygen from the atmosphere dissolves in river and lake water, and it is this oxygen that fish and other aquatic animals use to breathe. Dissolved Oxygen is that amount of gaseous oxygen (O_2) dissolved within the water. Oxygen enters the water by direct absorption from the atmosphere, by a rapid movement, or as a waste material of plant photosynthesis. Water temperature and therefore the volume of moving water can affect dissolved oxygen levels[6]. For example, oxygen cannot enter the water when it is covered in ice and so fish can often suffocate towards the onset of winter. The probabilities of winter fish kills are even higher if the fish reside in a polluted or overgrowing (over-productive) system. In polluted systems, overgrowth of animals, plants, and bacteria cause the oxygen to be depleted quickly, sometimes causing fish to suffocate. Most natural lakes and rivers within the Arctic do not have an overgrowth of animals, plants, and bacteria, and so "fish kills" at the onset of winter or during the warmest parts of the summer are rare. However, large-scale industrial development, heavy use of fertilizers, and dumping of excreta can pollute water quickly and result in oxygen starvation[6].

RESULTS AND DISCUSSION

Temperature

It is found that the temperature of the river water is within the permissible limit as per IS:10500, as the result shows the temperature of the river water collected during the winter season. The temperature varies between 22.5°C - 24°C [7].

pH Value

The pH is a measure of the intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water. It has no direct adverse effect on health. However, a low value, below 4.0 will produce a sour taste and a higher value above 8.5 shows alkaline taste. A pH range of 6.5 – 8.5 is normally acceptable as per the guidelines suggested by ISI. In the present study, the fluctuation of pH in the samples is from 8.3 to 8.9 [7].

Turbidity

Measurement of Turbidity reflects the transparency in water. It is caused by the substances present in water in suspension. In natural water, it is caused by clay, silt, organic

matter, and other microscopic organisms. It ranged from 2.9 to 3.05 NTU. However, the prescribed limit of Turbidity for drinking water is 5 NTU (IS: 10500). Turbidity was found within the permissible limit in all the water samples[7].

From site 1 and 2

Table 3

Parameters	Sampling sets		Temp °C	pH	COD	Conductivity	TDS	Turbidity	Total hardness (mg/L)	BOD	DO
Winter season	1	S1	23	8.9		0.66	342	2.923	286		
		S2	23	8.6		0.66	341	2.932	280		
		S3	22.5	8.7	14.5	0.65	332	3.010	284	3	8.68
		S4	22.8	8.7	25	0.65	327	3.058	283	3	8.82
	2	S1	23.4	8.6	17.5	0.66	342	2.923	267	3.2	8.96
		S2	23	8.7	24.6	0.64	334	2.994	267	3.2	8.95
		S3	23	8.4		0.64	327	3.058	273		
		S4	22.9	8.5		0.65	337	2.967	267		

Conductivity of Water

The electrical conductivity of water estimates total solids dissolved in water. The prescribed value is 0 mS cm^{-1} (IS: 10500) As the salt increases in the water, conductivity also increases. In the present study area, the conductivity is found to be 0.64-0.66 mS cm^{-1} [7].

Total Dissolved Solids

Total Dissolved Solids may be considered as salinity indicators for the classification of river water. The TDS in river water is due to the presence of Calcium, Magnesium, Sodium, Potassium, Bicarbonate, COD, and Sulphate ions. In the study area, TDS varied from 328 to 342 mg/l. As the prescribed limit of TDS for drinking water is 500 mg/l, all the water samples have TDS concentration well below the prescribed limit of TDS [7].

Total Hardness

The hardness of water is objectionable from the viewpoint of water used for laundry and domestic purposes since it consumes a large quantity of soap. Based on the present investigation, hardness varied from 209 to 286 mg/l. However, the permissible limit of hardness for drinking water is 300 mg/l (IS 10500)[7].

From site 3 and 4

Table 4

Parameters	Sampling sets		Temp °C	pH	COD	Conductivity	TDS	Turbidity	Total hardness (mg/L)	BOD	DO
Winter season	3	S1	24	8.5	19	0.65	328	3.048	272	3.5	8.72
		S2	24	8.5		0.65	334	2.994	230		
		S3	23.9	8.7	19.5	0.65	336	2.976	213	3.5	8.72
		S4	24	8.6		0.66	336	2.976	212		
	4	S1	22.8	8.5		0.65	329	3.039	210		
		S2	23	8.5	22.8	0.65	341	2.932	210	4	8.84
		S3	22.8	8.4		0.65	337	2.967	209		
		S4	23	8.3	13	0.66	342	2.923	212	4	8.8

Biochemical Oxygen Demand (BOD)

BOD gives a quantitative index of the degradable organic substances in water and is used as a measure of waste strength. The low BOD value in all samples showed the good sanitary conditions of the water. It is found that all the water supplied to the nearby area is within the permissible limit. (i.e. 3 to 4 mg/l)[8].

Dissolved Oxygen (DO)

Dissolved oxygen content in water reflects the physical and biological processes prevailing in water and is influenced by aquatic vegetation. Low oxygen content in water is usually associated with organic pollution. DO range is from 8.61 to 8.96 mg/l in the study area, whereas the prescribed limit for DO is 5.0 mg/l [8].

COD

In the study area, there is a significant change in COD concentration and it ranged from 13 to 22.8 mg/l. COD which has been associated with pollution as an index is found below the permissible value set at 250 mg/l in most of the study area. COD in excess (> 250 mg/l) imparts a salty taste to water and people who are not accustomed to high Chlorides can be subjected to laxative effects[8].

CONCLUSION

The average ranges of physical, chemical, and biological characteristics of water quality are as per the river water quality. The pH ranges from 8.3 to 8.9. The Turbidity, TDS, and Conductivity ranged from 2.932 to 3.05 NTU, 328 – 342 mg/L, and 0.64 to 0.66 mS cm^{-1} respectively. The value of Turbidity was found to be within the permissible limit in all the samples. Hardness ranged from 209 to 286 mg/l and it is found that the water supplied to the

campus area is soft. The DO and BOD were in the range of 8.68 to 8.96 mg/l and 3 to 4 mg/l. The COD and Alkalinity were in the range of 13 to 22.8 mg/l and 98 to 106.3 mg/l respectively[9]. The parameters studied resemble drinking water quality and hence it is concluded that Vena River water can be used for drinking and household purposes.

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