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Research Paper

Analysis of Physicochemical Properties of Yamuna River in Prayagraj city

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ABSTRACT
A study was carried out to determine the physicochemical parameters of Yamuna River water from four different sampling sites in Prayagraj city. River water samples were collected from two different location which was muthi ganj ghat and Allahabad Qila. Water quality of these two location were also compared with corresponding midstream sites. viz G1 (Ghat bankside), G2 (Ghat Midpoint), Q1 (Qila Bankside), Q2 (Qila Midpoint) of Prayagraj city, during the month of March, 2020 and River water samples were taken to the laboratory and analyzed. All the analyses were carried out as per World Health Organization guidelines for the parameters like Temperature, Transparency, Total Hardness of water, Dissolved Oxygen, free Carbon dioxide, Total alkalinity and Chloride ion were studied. The hardness and free Carbon dioxide of Yamuna water were found to be exceeding beyond the desired prescribed limit of World Health Organization therefore, it was concluded that untreated water of river Yamuna in Prayagraj city is unsafe for Domestic consumptions.
Keywords*: Yamuna , Prayagraj, Physicochemical parameter, water*

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I. INTRODUCTION

Water is prime necessity for all the living beings on earth. Water is most important requirement for all the life supporting activities on earth River, Lakes, Ponds and Wells are the basic source of Surface water availability which mostly used as untreated form for human consumption [1]. The Quality of water refers the component present in water, at the optimum level which is suitable for the growth of plants and animals. Aquatic organisms need a healthy environment to live and have adequate nutrients for their growth. The productivity of aquatic systems depends on the physicochemical characteristics of the water body. The maximum productivity obtained when the physical and chemical parameters are of water at optimum level [2].

The Yamuna is the largest tributary river of the Ganges (Ganga) in northern India, originating from the Yamunotri Glacier at a height 6,387 meters on the south western slopes of Banderpooch peaks. The cities of Delhi, Mathura, Prayagraj and Agra lie on its banks. Yamuna is one of the most polluted rivers in the world. Yamuna River covers as many as seven states and it flows almost entirely through Delhi, where it is exploited the most. In past the river used to be the main source of life for drinking water, communication and irrigation. Yamuna out numbers any other river in the number of industries on its banks because it passes through many major industrial cities. Yamuna is one of the sacred rivers and the largest tributary of the river Ganga. The water of the river Yamuna is also used for irrigation purpose so degradation in the water quality definitely will have some impact on agricultural purposes. The river water in the upper segment is relatively unpolluted. However, domestic and industrial water from urban and rural areas are discharged into the river polluting the downstream [4]. Yamuna is among one of the sacred river facing degradation in its water quality as a result of modernization. Prayagraj has its religious status because of the confluence of three sacred rivers viz., Yamuna, Ganga and Saraswati at Sangam. Every year during the winter season a religious festival is conducted for over a month in which thousands of pilgrims from all over the world come to take a dip in the Yamuna Prayagraj.

Thus, it becomes important to always keep an eye on the quality of the river water. The objective of this study is to assess the physical chemical parameters of Yamuna water and the pollution level in Yamuna river in Prayagraj city in march 2020.

II. MATERIAL AND METHODS

Sample sites and collection

Water samples were collected from four different sites muthi ganj ghat-MG1 (bank side), MG2 (mid point), Qila bank side (Q1), Qila mid point (Q2), of the river Yamuna at Prayagraj during March 2020, to analyze the quality of water in Prayagraj, parameter taken into consideration were Temperature, Transparency, DO, total hardness and free Co_2 , Total Alkalinity, Chloride All the sampling and analysis were carried out as per WHO standard methods.

Fig-A Qila bank side sampling site

First site was muthi ganj ghat which was comparatively a crowded place. Another site was Allahabad fort, which was less crowded. Water quality of these site were also compared with corresponding mid stream sites. Water samples from selected sites were collected from the surface in BOD bottles and plastic containers.

Fig-B Water sample collection

Temperatur by thermometer

Temperature was taken by the thermometer by directly dipping into the water in cloudy weather at 2:35 to 3:30 Pm, It was remain constant at every site i.e. 25◦C

Free Co_2 by NaOH Titrimetric method

50ml of water sample taken in conical flask, Added 2-3 drops of phenolphthalein indicator. Then titrated with NaOH solution (0.05 N). The colour of solution turned pink it indicated the presence free Co_2 the color of sample will remained constant if free Co_2 is absent.

Free CO_2 mg/L = mL of NaOH used X N of NaOH X 1000 X 44/ mL of Sample used

Total Hardness by EDTA Titrimetric method

50 ml of water sample taken in conical flask, then Added 5ml of Buffer solution then added pinch of Eriochrome Black-T. when the solution was turn into wine red in color, Then titrated the content with EDTA solution, till the colur of solution turn blue.

mg/L of $CaCO_3$ = Volume of EDTA used X 1000/ ml of Sample used

Transparency with the help of sacchi disc

Transparency was measured by lowering the secchi disk at respective sampling point, The depth at which it disappeared in water (D) and reappeared(R) was noted the transparency of water body was calculated. Transparency (cm) =D+R/2

Dissolved Oxygen by Winkler's Method

300 mL sample from BOD bottle taken into the flask , added 2 mL of $MNSO_4$.$4H_2$ O followed by 2ml of alkaline KI, a brown precipitation was formed. Allowed the floculent settle down then added 2 mL of conc. H_2 SO_4 by inserting the tip of pipette .draw 100ml of treated sample with a pipette and introduced in conical flask titrated the solution with 0.025N of N_2 S_2 O_3 .$5H_2$ O. added five drops of starch solution the solution turned blue, continue titration till the first complete disappearance of blue color.

Dissolved Oxygen (D.O) mg/L= 8x1000x N of Na_2 S_2 O_3 V of Na_2 S_2 O_3 / Volume of sample

Alkalinity by Titration method

50 mL of water sample taken in a conical flask and 1 drop of Phenolphthalein indicator was added, solution appeared colorless it means Phenolphthalein alkalinity is zero. (PA=0). At PA=0, 3 drops of Methyl Orange Indicator was added to the same conical flask, a yellow colour appeared then solution was Titrated with 0.1 N HCl till the colour of solution changed from yellow to orange.

Phenolphthalein alkalinity (mg/L) = AxN Of Hclx 1000x50 / Sample used in mL

$$\text{Total alkalinity (TA) (mgLl)} = \frac{\text{B x N of Hcl x 1000x50}}{\text{Sample used in mL}}$$

Chloride By difference

50 mL of water sample was taken into the conical flask. Added 6 drop of KMnO4 indicator, color of sample turned yellow then sample was Titrated with silver nitrate solution until a persistent brick red colour appeared.

Chloride (mg/L)= $AgNo_3$ used (mL) X "N" of $AgNO_3$ X 1000 X 35.5/ Sample used in mL

III. RESULTS AND DISCUSSION

Dissolve Oxygen

The maximum dissolved oxygen was recorded to be 6.1mg/L in the month of March at Q2 and the minimum DO was recorded to be 1.3mg/L ,at Q1 because Q1 was bank side of Qila and there was too much growth of phytoplankton and microorganism so DO has consumed by Phytoplanktons for their all biological activities and maximum DO found at MG2 which is mid point of muthi ganj ghat area of running water and more deeper than MG1 (table-1) so the biological activities of microorganisms less in running water. Decrease in DO is due to increase in biological and photosynthetic activity [5]. The DO value was found with in limits prescribed by WHO.

Total Hardness

The hardness of water was found to be minimum at MG2 which is 202 mg/L of CaCO3 and maximum at Q 1 which is 225.6. The WHO, ISI standard of hardness is 100 and ISI standard is 300. The hardness is the property of water in which the cations & anions takes important role at MG2 the ions were less in comparison to other places, at Q1 the water was rich in flora and fauna because the highly alkaline and highly alkaline water are rich in phytoplankton specially the blue green algae [1] (Table-1). Calcium and Magnesium are main cations for Hardness and Carbonates, Bicarbonate, Sulphate are main anions for Hardness of water**.** The total hardness values was found with in limits prescribed by is 10500-91.

Temperature

The water temperature is found to be minimum at MG2 and Q2 which is 25^0C and maximum in Q1 which 26^oC Temperature is the most important factor which influences the chemical, biochemical, and biological characteristics of the aquatic systems [6]. The temperature of MG2 and Q2 was minimum because this area is the middle part of the river, this is the running water (Table-1). As the temperature increases the solubility of O_2 and other gases decreases. This means the colder stream water hold more dissolves O_2 than the warmer water. Temperature impact the rate of metabolism, growth of aquatic organism, rate of photosynthesis and toxic material. Temperature also affect the electrical conductivity of water, water with high temperature dissolve more minerals and therefore high electrical conductivity.

Free Co_2

Free carbon dioxide is carbon dioxide that exists in the environment. It is present in water in the form of a dissolved gas. Surface water normally contains less than 10 ppm of free carbon dioxide [3]. while some ground waters may exceed that concentration. The maximum Co_2 70.4 mg/L in month of march at MG1 because MG1 is a bank point of river which was crowded area of ghaat and rich in anthropogenic activity which increase the temp of water and free co2 dissolved. Where as minimum co_2 was found in 8.8 mg/L at Q2 and GG2 which was mid point of river and running water take place which decrease amount of free co2 (Table-1). The free Co_2 value was found to be greater than the prescribe limits by WHO.

Transparency

The transparency of water was found to be minimum in MG1 37.5 cm and maximum in Q2 which is 125.5 Cm. The MG1 transparency was low because the river is not very deep and highly polluted in this place dumping of waste, washing clothes and bathing of animal people takes place hence transparency is low. The Q2 area was very deep because it was the middle part of the river (Table-1).

Chloride

Chloride is major ions found in water, chloride ions leaches from rocks, soil by weathering. Chloride concentration of Yamuna river was found to be maximum at MG1 while minimum to be found at Q2 site (Table-1). High concentration of chloride ion in water is harmful for plant and fishes. Increased concentration of chloride ion is due to human activity and sewage contamination [7].

Total Alkalinity

Alkalinity is the measurement of carbonates, bicarbonates and OH^- ions in the water. Total alkalinity of Yamuna river was found to be maximum at Q2 and minimum at Q1 (Table-1). Quila mid point area of running water and less human activity was found. High alkalinity concentration is good for aquatic animals which shows that the water can neutralize a high amount of acid.

Fig-C Assessing the physicochemical parameters of water sample

Statistical analysis

Interrelationship studies between different variables are very important and useful in research. The study of correlation between different variables reduce the range of uncertainty and also helpful in decision making . The correlation co-efficient 'R' was calculated to understand the relationship among the parameters using formula –

$$R = \frac{N\sum (XY) - (\sum x).(\sum Y)}{\sqrt{[N\sum X2 - (\sum X)2][N\sum Y2 - (\sum Y)2]}}$$

Table-1
Average results of the physiochemical parameters

S.N	Parameter	Sampling points				WHO 1993	ISI Standard 10500-91
		MG1	MG2	Q1	Q2		
1	Temperature	25.33	25.0	25.83	25.5	……	……
2	Transparency	37.49	92.4	90.33	125.3	Less than 5	.....
3	Free CO_2	73.04	4.40	11.88	8.80	Less than 1o ppm	…..
4	D.O.	1.7	5.53	1.13	6.10	>5 mg/L	500
5	Total Hardness	212	202	225.2	204.6	150-500	300
6	Total Alkalinity	132	130	129.3	133.3	------	200-600 mg/L
7	Chloride	220	100	210	66.31	<250 mg/L	250–1000 mg/L

Note -All parameters are in mg\L except Temperature and transparency in degree ◦c. and Cm.

Table-2
Matrix of correlation among water quality parameter

Parameter	Transparency	Hardness	Temp	Free Co_2	BOD	Chloride	alkalinity
Transparency	1						
Total Hardness	-0.281	1					
Temperature	0.1760	0.8186	1				
Free Co_2	0.8909	0.1599	-0.0699	1			
BOD	0.687	-0.9858	-0.5462	-0.5571	1		
Chloride	-0.7987	0.8019	0.4054	0.6569	-0.9858	1	
Total alkalinity	0.1402	-0.5181	-0.094	0.3019	0.4335	-0.4081	1

It can be seen from Table -2 the highly positively correlated values are found between chloride and free Co_2 while the low negatively correlated values were found between BOD and total alkalinity.

IV. CONCLUSION

In the present study it was found that the maximum parameters were at the level of pollution except free Co_2 and total hardness. Therefore it was concluded that River Yamuna in Prayagraj City was polluted and untreated water is unsafe for domestic consumption. The decline of Yamuna River water quality at Prayagraj due to both point and non-point sources of pollution i.e. large as well as small scale industrial units and agriculture sectors of the city.

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