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### RESEARCH ARTICLE

## EVALUATION OF PHYSICOCHEMICAL CHARACTERISTICS OF GOMTI RIVER WATER AT UTTAR PRADESH, INDIA.

Hafizurrahman<sup>1\*</sup>, Abrar Ahmad<sup>2</sup>, MohdMabood Khan<sup>3</sup> and ZulfiqarAli<sup>1</sup>.

1. Department of Chemistry, Integral University, Kursi Road, Lucknow, India.
2. Environmental Biotechnology Division, CSIR-IITR, MG Road, Lucknow, India.
3. Department of Pathology, King George Medical University, Lucknow, India.

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#### Abstract

The aim of the study is to find out the water quality of the Gomti River of Uttar Pradesh. River Gomti is an important River of Uttar Pradesh, originate from the FulhaarJheel present in Pilibhit region in Uttar Pradesh. The River goes for a distance of about 900 km, passing through Uttar Pradesh finally to join River Ganges in Ghazipur in the area of Saidpur. Different cities that are located along the banks of the River Gomti are Sultanpur, Lucknow, Jaunpur and these are the main cities that are prominent in the region, out of the total 15 cities in the catchment land. A total 10 parameters namely Temperature, pH, Total dissolved solids (TDS), Total hardness, Alkalinity, free CO<sub>2</sub>, Dissolved oxygen (DO), Biological oxygen demand (BOD), Chemical oxygen demand (COD) and Chlorides were analyzed and their seasonal variation is discussed to obtain the impact of effluents on water quality. The observed values of different physicochemical parameters were compared with standard values recommend by World Health Organization (WHO) and Bureau of Indian Standard (BIS). From the result it was found that the most of the parameters of Gomti River water are within the permissible limit of WHO and BIS but some parameters like pH, BOD and DO were found higher than the permissible limit of WHO and BIS.

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#### Introduction:-

Gomti River is one of the important tributaries of Ganga River which originates from a lake FulhaarJheel near Mainkot in Madhotanda, Uttar Pradesh and finally to join River Ganges in Gazipur. Four cities, Lucknow, Barabanki, Sultanpur and Jaunpur, are situated on the banks of this River. Water is absolutely essential for survival of human beings, animals, plants and other living beings because without water no life can exist (Patel, *et al.*, 2015). Water pollution is a major global problem. Due to discharge of industrial effluents, domestic and sewage water, agricultural wastes and decaying materials of human, animals and plants polluted Indian Rivers day by day (Asthana, *et al.*, 1997). It has been reported that water pollution leading worldwide cause of deaths and diseases and accounts for the deaths of 14,000 people daily (West, 2006). The main source of water pollution specially for Rivers flowing within the city are drains, which carry industrial effluents, domestic waste, sewage and medicinal waste causing water pollution (Srivastava, *et al.*, 2011). The geochemical, geomorphological, climatic pollution nature of fresh water was characterized by the physicochemical parameter of water body (Chaurasia and Pandey, 2007). To

**Corresponding Author:-Hafizurrahman.**

Address:-Department of Chemistry, Integral University, Kursi Road, Lucknow, India.

ensure that the water is palatable and safe for drinking it is necessary to comply with physical, chemical and microbiological standards (Tebutt, 1983). According to the WHO reports approximately 36% of urban and 65% of rural Indian were without access to safe drinking water (Akoto and Adiyiah, 2007). Keeping in view of the above facts the present work was focused to analyze physicochemical parameter of Gomti River water in Lucknow, Barabanki, Sultanpur and Jaunpur district affected by domestic wastes, agricultural wastes and sewage water which deteriorate the quality of water.

## **Materials and Methods:-**

### **Study Area:-**

Gomati River, also called Gumti, tributary of the Ganges (Ganga) River, central Uttar Pradesh state, Northern India. The River goes for a distance of about 900 km, passing through Uttar Pradesh finally to join River Ganges in Ghazipur. Different cities that are located along the banks of the River Gomti are Sultanpur, Lucknow, Jaunpur and Lakhimpur Kheri, Barabanki and these are the main cities that are prominent in the region, out of the total 15 cities in the catchment land. The Gomti River catchment area is of about 25,800 km<sup>2</sup>. The nine-sampling sites were selected for quantitative analysis of the physicochemical parameter in water column of the Gomti River. The selected sites are, Site 1. Neemsar, Lucknow: About 100 km upstream of Lucknow.

Site 2. Gaughat, Lucknow: Upstream of the Lucknow city near the water supply intake point from River.

Site 3. Mohan Meakins, Lucknow: Downstream of the Mohan Meakins distillery in the central city. Between Gaughat and Mohan Meakins locations, there are several outfalls/drains discharging into the River directly.

Site 4. Pipraghat, Lucknow: In the cantonment area, downstream of Lucknow.

Site 5. Barabanki, Downstream of Lucknow, Reith River, a tributary of Gomti River bringing wastewater/effluents from the Barabanki town (left) and Luni River from the right side joins the main River channel upstream of this location.

Site 6. Gola Ghat, Sultanpur: About 10 km upstream of the Sultanpur town.

Site 7. Aam Ghat, Sultanpur: Downstream of the Sultanpur town.

Site 8. Hanuman Ghat, Jaunpur: About 10 km upstream of the Jaunpur city.

Site 9. Miyanpur Ghat, Jaunpur: About 3 km downstream of the Jaunpur.

### **Collection of water sample:-**

In the present study, seasonal variations in physical and chemical parameters of Gomti River were studied. The sampling was done on winter season December 2015, summer season May 2016 and rainy season August 2016. The sample was collected from below the water in plastic bottles of 2 L capacity and stored for further analysis. The samples were analyzed for 10 different physicochemical parameters namely Temperature, pH, Total dissolved solids (TDS), Total Hardness (TH), Alkalinity, Free CO<sub>2</sub>, Biological oxygen demand (BOD), Chemical oxygen demand (COD), Dissolved oxygen (DO) and chlorides.

### **Physicochemical analysis:-**

The parameters like Temperature, pH, TDS, Alkalinity, Total hardness, Free CO<sub>2</sub>, BOD, COD, DO and Chlorides were analyzed by using APHA, (1999) standard procedures. Total dissolved solid (TDS) was determined gravimetrically by evaporating a known amount of volume. pH was determined by digital pH meter. Temperature was measured by thermometer. Dissolved oxygen (DO) was measured by Azide modification titrimetric method. Chemical oxygen demand (COD) was determined by Open reflux methods. Biological oxygen demand (BOD) was determined by 5 days BOD test. Hardness of water was determined by EDTA titrimetric method. Chloride was analyzed by Argentometric titrimetric method. Free CO<sub>2</sub> was determined by titrimetric method using phenolphthalein as an indicator at pH 8.3. Alkalinity was also determined by titrimetric method. The results obtained by different tests carried out on physicochemical properties of River water samples comprises with the World Health Organization (WHO, 2008), Bureau of Indian Standard (BIS, 2004) specified for drinking water.

## **Results and Discussion:-**

In the present study total of 10 physicochemical parameters were analyzed namely Temperature, pH, Alkalinity, TDS, BOD, COD, DO, Free CO<sub>2</sub>, Total hardness and Chlorides. The physicochemical properties of River Gomti were recorded in different seasons and at different sites as listed in Table 1 and Table 2.

**Temperature**

In winter season the highest value of 21.7°C temperature was found at Barabanki and lowest value of temperature 19.3°C was found at Golaghat. In summer season the highest value of temperature 33.8°C was at Gaughat and lowest value temperature 30.6°C was at Barabanki. In rainy season the highest value was 28.9°C at Hanuman ghat and lowest value 23.5°C was found at Golaghat. Similar observation have also reported by other workers in Indian Rivers, especially in Ganga (Kannan, 2000), in Gomti River (Arti Saxena, 2016) and Purna River, Maharashtra (Meitei, *et al.*, 2004). The variation in temperature is mainly related with the atmospheric temperature and weather condition (Adebowale, *et al.*, 2008).

**pH:-**

In winter season the highest value of pH 8.56 was at Pipraghat and lowest value 7.25 at Golaghat. In summer season the highest value 8.58 was at Pipraghat and lowest value was 7.23 at Miyanpurghat. In rainy season the highest value was 8.9 at Hanuman ghat and lowest value 7.35 at Golaghat. The value of pH expresses about the intensity of acidity and alkalinity of an aquatic environment (Kamal, *et al.*, 2007). Bhagat, *et al.*, 2013 has reported pH value within the range of 9.2-11.7 in Sutlej River Punjab and Purushottam, *et al.*, 2016 reported within the range of 7.8-8.6 in Gomti River.

**Total dissolved solids (TDS):-**

Total dissolved solids are the amount of solid materials dissolved in water including salts, some organic materials and a wide range of other things from nutrient to other toxic materials.

In winter season the highest value 650.5 mg/l was at Hanuman ghat and lowest value 357 mg/l was at Neemsar. In summer season the highest value 667.5 mg/l was at Hanuman ghat and lowest value 455 mg/l was at Neemsar. In rainy season the highest value 498 mg/l was found at Pipraghat and lowest value 347 mg/l was at Neemsar.

**Alkalinity:-**

Alkalinity of water is the capacity to neutralize strong acids and forms carbonate, bicarbonate, hydroxide content by the dissolution of CO<sub>2</sub> in water. In winter season the highest value 234 mg/l was at Neemsar and lowest 133 mg/l at Pipraghat. In summer season the highest value 232 mg/l at Neemsar and lowest value 129 mg/l at Pipraghat. In rainy season the highest value 246 mg/l was at Aamghat and lowest value 198 mg/l was at Mohanmekin. Similar results also observed by (Tabrez, *et al.*, 2010) in Gomti River water.

**Total hardness (TH):-**

In the winter season the highest value 230 mg/l was at Aamghat and lowest value 154 mg/l was at Neemsar. In summer season the highest value 242 mg/l was found at Mohanmekin and lowest value 198 mg/l at Pipraghat. In rainy season the highest value 212 mg/l was at Aamghat and lowest value 176 mg/l was at Mohanmekin. The hardness of natural waters depends mainly on the presence of dissolved calcium and magnesium salts (Ikomi and Emuh, 2000) and permanent hardness is mainly caused by chlorides and sulphates present in water (Roy, *et al.*, 2002). The higher value of total hardness at different sites may be due to use of soaps and detergents by washer men and also discharge of the domestic wastes through drains. Total hardness has no adverse health effects except for imparting taste (WHO, 1996).

**Free CO<sub>2</sub>:-**

In the winter season the highest value was 62.3 mg/l and lowest value 38.6 mg/l was at Neemsar. In the summer season the highest value 68.5 mg/l and lowest value 43.6 mg/l was at Neemsar. In the rainy season the highest value was 58.2 mg/l at Mohanmekin and the lowest value was 46.2 mg/l at Gaughat. Relatively higher values of free CO<sub>2</sub> were observed during rainy season because in summer due to high temperature the respiratory activities of aquatic organisms accelerated by process of decay of organic matter, producing large amount of CO<sub>2</sub> in the water (Pramod, *et al.*, 2014). Similar results were observed by (Preetysingh, 2014) in Gomti River and (Meitei, *et al.*, 2004) in Purna River.

**Biological oxygen demand (BOD):-**

In the winter season the highest value 6.4 mg/l was at Mohanmekin and lowest value 3.1 mg/l was at Golaghat. In the summer season the highest value 6.2 mg/l was at Mohanmekin and lowest value 3.8 mg/l was at Neemsar. In the rainy season the highest value 6.7 mg/l was at Mohanmekin and lowest value 2.8 mg/l was at Aamghat. Due to biodegradation of organic materials Biological oxygen demand increases and exerts oxygen tension in a water body

(Abida and Harikrishna, 2008). BOD has been used to detect the amount of organic materials in water which supports the growth of microorganism (Goel, 2006). In the present study, the average value found was 4.6mg/l is higher than the value obtained by the in Yamuna River (Khawaiwal, *et al.*, 2003) and in Ganga River (Khanna, *et al.*, 2007) correspondingly.

#### **Chemical oxygen demand (COD):-**

In the winter season the highest value 21.5mg/l was at Hanuman ghat and lowest value 13.6mg/l was at Barabanki. In the summer season the highest value 21.8 mg/l was at Mohanmekin and lowest value 12.5mg/l was at Golaghat. In the rainy season the highest value 22.4 mg/l at Mohanmekin and lowest value 12.8 mg/l at Neemsar. Low levels of COD indicate about comparatively less pollution load and high level of COD due to performance of worship rituals and abundance anthropogenic activities. Semwal and Akolkar, 2006 reported COD range between 11.0-18.3mg/l in Ganga River. Singh, *et al.*, 2013 reported COD range 37.6-60.8 mg/l in Gomti River and Zeb, *et al.*, 2011 reported COD range between 20.7- 28.2mg/l in Siran River Pakistan.

#### **Dissolve Oxygen (DO):-**

In the winter season the highest value 12.4 mg/l was at Barabanki and lowest value 7.8 mg/l was at Gaughat. In the summer season the highest value 11.9 mg/l was at Barabanki and lowest value 7.8 mg/l was at Hanuman ghat. In the rainy season the highest value 13.5mg/l was at Neemsar and lowest value 7.6 mg/l was at Hanuman ghat. The deficiency of the oxygen in the water is favorable condition for bacteria and other pathogens, which are anaerobic and injurious to human health Radha,*et al.*, 2007. Dissolved oxygen concentration is a most important Indicator of water pollution (Basavaraddi, *et al.*, 2012). Similar observation also found by (Dhananjay, *et al.*, 2013) in Gomti River water, in the Ganga River water values ranged between 9.50-11.0 mg/lit Bhutani, *et al.*, 2014).

#### **Chlorides:-**

In the winter season the highest value 26 mg/l was at Gaughat and lowest value 16.5 mg/l was at Golaghat. In the summer season the highest value 31.6 mg/l was at Aamghat and lowest value 19.4 mg/l was at Neemsar. In the rainy season the highest value 24.3 mg/l was at Golaghat and lowest value 18.9 mg/l was at Neemsar. The chloride concentration indicates about the pollution caused by sewage. Higher chlorides in water are subjected to laxative effects in people (Dahiya, *et al.*, 1999). The value of Chloride increases with the increasing of eutrophication (Mahananda, *et al.*, 2010). Chlorides and sulphates produce permanent hardness in water (Roy, *et al.*, 2002).

**Table1:-**Physicochemical data of Gomti River in Winter, Summer, Rainy season at different site.

Sites	Temp	pH	Alkalinity	TDS	Free CO <sub>2</sub>	BOD	COD	DO	TH	Chloride
<b>December 2015 (Winter season)</b>										
1	21.3	7.34	234	357	38.6	3.8	14.4	11.4	154	17.2
2	22	7.26	215	398	44.3	4.2	15.8	10.2	176	16.5
3	20.2	8.34	140	425	53.8	4.8	20.2	9.1	198	25.2
4	19.5	8.56	133	620	50.2	6.4	19.6	10.6	166	18.3
5	21.7	7.45	188	572.5	51.6	3.1	13.6	12.4	186	22.6
6	19.3	7.25	167	438	58.2	3.6	15.3	7.8	220	26.0
7	21.6	8.22	144	455	55.6	4.2	17.0	8.2	230	24.6
8	20.0	7.92	198	650.5	62.3	4.4	21.5	8.5	213	22.2
9	19.7	7.50	205	548	52.4	4.0	18.7	8.7	198	21.8
Average value	20.56	7.76	180.44	462.66	51.88	4.6	17.31	9.65	193.44	21.6
<b>May 2016 (Summer season)</b>										
1	33.8	7.62	232	455	43.6	3.8	16.3	11.7	199	19.4
2	33	7.85	212	468	48.3	4.6	15.4	11.1	216	20.8
3	31.2	8.48	156	558	68.5	6.2	21.8	9.8	242	23.3
4	32	8.58	129	650.5	57.9	5.5	17.5	11.3	198	20.9
5	30.6	7.92	168	543	54.5	4.9	14.6	11.9	215	24.2
6	32.8	7.56	220	486	60.3	3.9	12.5	10.2	237	29.3
7	31.0	8.20	214	526	52.7	4.9	16.2	9.2	220	31.6
8	33.3	7.90	198	667.5	62.1	4.5	20.7	7.8	225	26.9
9	31.4	7.23	167	520	51.8	3.8	16.3	8.2	217	25.7
Average value	28.56	7.92	188.44	541.55	55.52	4.6	16.81	10.13	218.77	24.67
<b>August 2016 (Rainy Season)</b>										
1	27.6	7.56	234	347	48.4	4.6	12.8	13.5	201	18.9
2	26.0	7.24	220	358	46.2	4.1	13.6	12.3	197	19.3
3	27.2	8.12	198	420	55.5	6.7	18.3	10.2	188	22.6
4	25.6	7.88	216	498	58.2	5.9	22.4	11.4	176	21.2
5	26.1	7.98	212	350	53.3	5.3	19.5	11.9	190	23.5
6	23.5	7.81	235	415	48.9	2.8	21.2	9.9	195	24.3
7	24.6	7.70	246	463	50.0	3.5	20.0	10.5	212	21.5
8	28.9	7.88	233	388	55.2	3.6	18.9	7.6	187	22.8
9	26.2	8.36	220	423	51.0	4.2	20.5	8.5	192	20.1
Average value	26.18	7.83	223.77	406.88	51.85	4.52	18.57	10.66	214.44	21.57

**Table 2:-**Comparative estimation of experimental values with WHO and BIS standards.

S. No.	Parameters	Units	Standard permissible limit (Max.)	Experimental values (Range)
1	Temperature	C <sup>o</sup>	-----	19.3-33.8
2	pH	-	6.5-8.5 (BIS)	7.23-8.58
3	TDS	mg/l	1000 (WHO)	347-667.5
4	BOD	mg/l	6 (WHO)	2.8-6.7
5	COD	mg/l	200 (WHO)	12.5-22.4
6	DO	mg/l	6 (BIS)	7.6-13.5
7	Free CO <sub>2</sub>	mg/l	--	38.6- 68.5
8	Alkalinity	mg/l	600 (BIS)	129-246
9	Total hardness	mg/l	500 (WHO)	154-242
10	Chlorides	mg/l	250 (WHO)	17.2-31.6

## Conclusion

Physicochemical analysis was performed on Gomti River water samples collected from various district in Uttar Pradesh, India. The results obtained in this study provide the characteristics of water, most of all parameters are within permissible limits except pH, BOD and DO. Thus the present study revealed that the Gomti River was highly polluted and the water quality is not now in safe limit for human, flora and fauna. Therefore, to maintain, and improve the of quality water it is necessary to provide awareness in people for cleanness of River and also should be continuous monitoring of pollution level is necessary and immediate action is required for its better management.

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