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A short period assessment of water physicochemical characteristics of Hooghly river, West Bengal, India

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Abstract

A systematic study has been conducted to assess the water quality of Hooghly river at Shyamnagar, from September 2015 to March 2016. The site is densely populated as well as one of the important industrial belt of West Bengal. Water samples were collected fortnightly from four sampling stations and Dissolved oxygen (DO), free carbon dioxide (free CO_2) and pH were determined. Study revealed a significant inverse relation between DO and free CO_2.Moreover, water pH also found to alter with the level of free carbon dioxide. Overall assessment of alkalinity (263.485±15.69 ppm) and salinity (51.47±2.41 ppm) indicated the levels within acceptable limit. Whereas, turbidity (70.378±7.36 NTU) of Hooghly river water was above the acceptable limit and was probably due to silt and also industrial effluents, sewage, as well as partly and fully decomposed organic matters received during the long journey of Ganga and finally these materials are flown through Hooghly river and water in this region is more turbid than the upper stream. Study also revealed that river water of this area have moderate hardness as well as Ca and Mg level with in permissible limit.

Keywords: Physicochemical parameters, Hooghly river, Dissolved oxygen, Hardness, Turbidity.

Introduction

As a vital and vulnerable freshwater ecosystem all rivers of the world are becoming critical for the sustenance of all aquatic life. It is a matter of serious concern that the degenerating water quality of fresh water systems put at risk their sustainability. People use the river water for different purposes. But continuous urbanization along with other unscrupulous human activities and domestic wastes are deteriorating water quality of river[1,2]. An excess level of some parameters like pH, TDS, turbidity etc. from water samples of Ganga[3]. Analyses of physicochemical characteristics of the water sources are required to measure the degree of water pollution[4]. Animal and plants are finally affected due to unacceptable changes in the different characteristics of an ecosystem by the conscienceless human activities on our planet earth[5]. When an industry discharges a litre of waste water, in turn that water pollutes on an average eight litres of freshwater[6]. Good quality water is essential for improved life and to prevent diseases. Natural water is polluting continuously by mining, and other human activities as well as disposal of unprocessed industrial and domestic wastes directly in the river[7]. Water quality of river was found to deteriorate mainly due to industrial runoff and household wastes and high hardness as well as alkalinity and a low level of dissolved oxygen were the indications of water pollution[8,9].

All organisms including terrestrial and aquatic, as well as microorganisms to man requires water, are facing serious problems today. The problems arise because of unplanned urbanization and industrialization[10]. Hooghly river, a tributary of Ganga, originating near Farakka, Bhagirathi enters in West Bengal and another part flows through Bangladesh as Padma, Also known as Bhagirathi-Hooghly, approximately 260 km long, and an integrated part of the life of the people of West Bengal. Hooghly is receiving different industrial and domestic effluents, while flowing through West Bengal[11]. A regular survey of different physicochemical parameters of Ganga river water is essential as this river is regularly exposed to anthropogenic interferences and the information on such parameters are very scanty. Here an attempt has been made to overcome these lacunas.

Methodology

Hooghly river, a tributary of Ganga, originated near Farakka of Murshidabad district and enters in South Bengal. The study was conducted near Barrackpore (located at 27'76° N, 88'37°E), which was extended about 4 km at the East bank of Hooghly river. This is an densely populated area and an important industrial zone of West Bengal. The study site was divided into four sampling stations namely MPG (Mangal Pandey Ghat), RRG (Ranirashmoni Ghat), GPG (Ghatakpara Ghat) and DBG (Dhobi Ghat) respectively.

Sampling was done between September 2015 and March 2016. Sample of subsurface water were collected fortnightly in the morning between 7 am and 8 am. Sampling was done carefully to avoid spilling of water and air bubble. Dissolved Oxygen,

free Carbondioxide, Alkalinity, Salinity, Hardness, Calcium and Magnesium were assessed at the sampling stations following the standard methods[12]. Whereas, Turbidity and pH were measured by Naphlo Turbidity Meter (Systronics 135) and Digital pH Meter (Systronics 335). Results were subjected to statistical analyses.

Results and discussion

Dissolved Oxygen (DO) at MPG ranged between 2.0ppm and 3.3 ppm with minimum in March and maximum in January (Figure-1). RPG revealed maximum level 3.57 ppm during the month of January and a minimum was recorded at 1.76 ppm in March. The DO content at GPG was minimum in March (1.55 ppm) and 4.91 ppm maximum in November. Whereas, DBG showed minimum 1.9 ppm and maximum 3.69 ppm during the month of March and January respectively. Data also revealed a mean DO of 2.73±0.195ppm, 2.83±0.24ppm, and 2.97±0.38ppm and 2.82±0.3 ppm at MPG, RRG, GPG and DBG respectively. Pooled data exhibited an average DO of 2.87±0.14 ppm (Table-1).

In compare to the DO, free CO_2 of Hooghly river water at MPG ranged from 1.8 ppm to 2.51ppm with minimum in March and maximum in November (Figure-2) with a mean value of 2.1±0.087 ppm (Table-1). At RRG the range was 1.9 ppm in September and maximum 2.15 ppm during March with a mean of 2.01±0.041ppm. Free CO_2 at GPG ranged from 1.8 to 2.3 ppm with minimum in December and maximum in March. In this sampling site the mean value was 1.98±0.067 ppm. D BG exhibited a range between 1.75 and 2.0 ppm with an average of 1.9±0.038 ppm. Pooled data showed a mean of 2.0 ±0.03 ppm free carbon dioxide in the study area.

The total alkalinity at MPG ranged from 185 to 460 mg/ml with minimum in March and maximum in September (Figure-3). At station B, alkalinity ranged between 180 to 470 mg/ml. The alkalinity at Station C was minimum in March (150 mg/ml) and maximum in September (350 mg/ml), whereas, it was ranged between 175 and 450 mg/ml with a minimum during March and maximum during September with an average of 261.071±33.60 mg/l at DBG (Table-1).

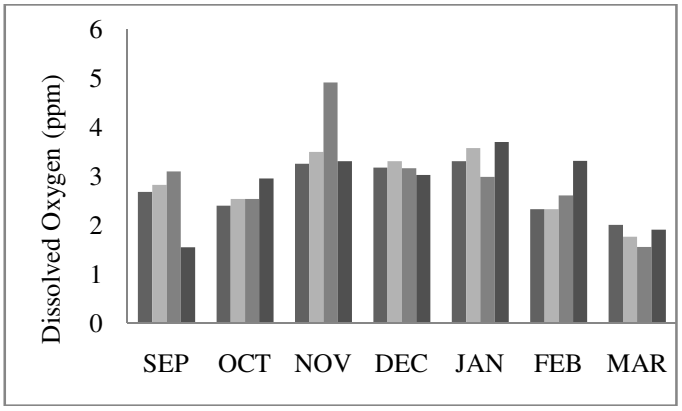

Figure-1: Level of Dissolved Oxygen in Ganga water collected from four sites.

The water hardness varied from 152 to 257 ppm at MPG (Figure-6) with calcium (Ca) content ranged between 26.9 and 74.03 ppm (Figure-7) and magnesium (Mg) content from 9.41 to 24.326 ppm (Figure-8.). Hardness was minimum during November and reached it maximum level at February whereas, Ca and Mg reached the maximum level in January. After September Hardness gradually increased at RRG and reached the maximum level during January (261 ppm) then came down to 167 ppm in the month of March. Ca content ranged between 39.5 ppm (March) and 91.6 ppm (February). Whereas, Mg was found minimum (2.78 ppm) in October and reached the maximum level September (17.79 ppm). Hardness ranged from 153 ppm to 292 ppm at GPG, where Ca and Mg were ranged between 38.6 and 103.8 ppm and 7.96 and 18.09 ppm respectively. At DPG Site lowest hardness was observed 173 ppm in November and reached the maximum level (284 ppm) during February. Ca showed its lowest value 27.75 ppm in September and highest 80.76 ppm during the month of February. On the other hand, Mg had lowest value (10.4 ppm) in November and highest 35.3 ppm during September.

Table-1: Mean values with SE of different parameters of different stations.

Sampling Station ----------→	Mangal Pandey Ghat	Ranirashmoni Ghat	Ghatakpara Ghat	Dhobi Ghat	Pooled Data
DO (ppm)	2.73±0.195	2.83±0.24	2.97±0.38	2.82±0.3	2.87± 0.14
Free CO_2(ppm)	2.1±0.087	2.01±0.041	1.98±0.067	1.9±0.038	2.0±0.03
pH	6.521±0.09	6.328±0.15	6.642±0.08	6.457±0.15	6.49±0.06
Alkalinity (mg/ml)	275.614±33.58	274.685±36.28	242.571±22.12	261.071±33.60	263.485±15.69
Salinity (mg/ml)	43.911 ± 5.18	55.73±4.21	51.83±5.34	54.621±4.51	51.47±2.41
Turbidity (NTU)	67.53±11.41	76.66±15.56	61.7±16.57	75.59±15.39	70.378±7.36
Hardness (ppm)	197.27±14.16	194.35±16.02	206±20.45	217.14±16.18	203.69± 8.35
Ca (ppm)	50.45±6.75	55.54±6.42	58.35±9.31	54.4±16.18	54.68±3.79
Mg (ppm)	19.10±1.93	10.75±1.93	14.67±2.91	20.19±3.10	16.18±1.23

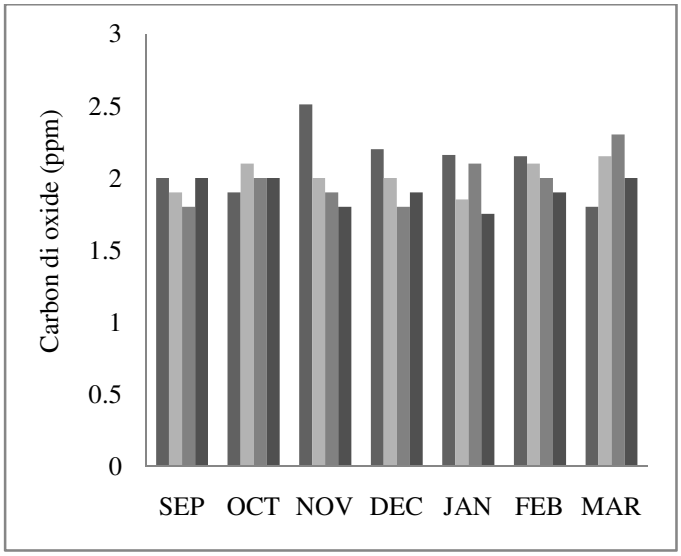

Figure-2: Level of Free Carbon di oxide in Ganga water collected from four sites.

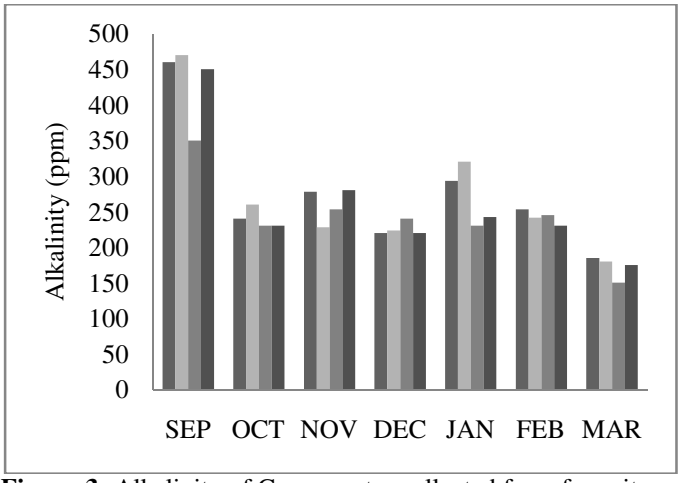

Figure-3: Alkalinity of Ganga water collected from four sites.

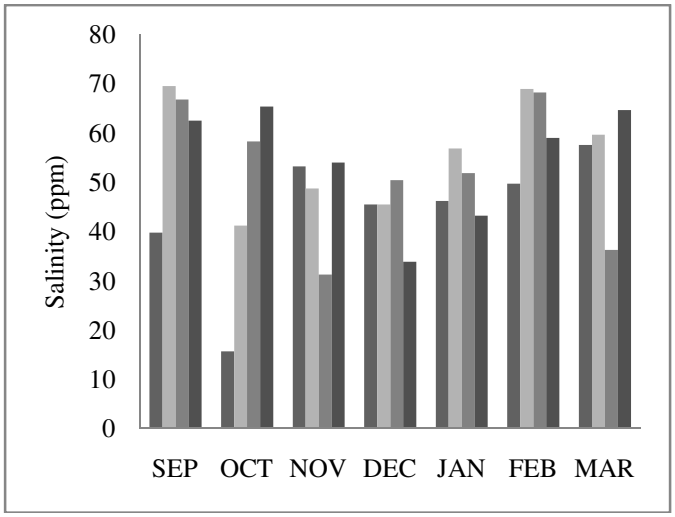

Figure-4: Salinity of Ganga water collected from four sites.

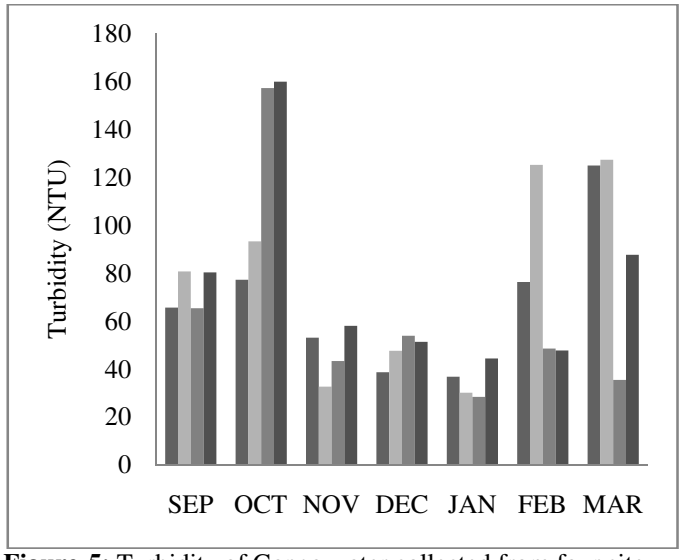

Figure-5: Turbidity of Ganga water collected from four site.

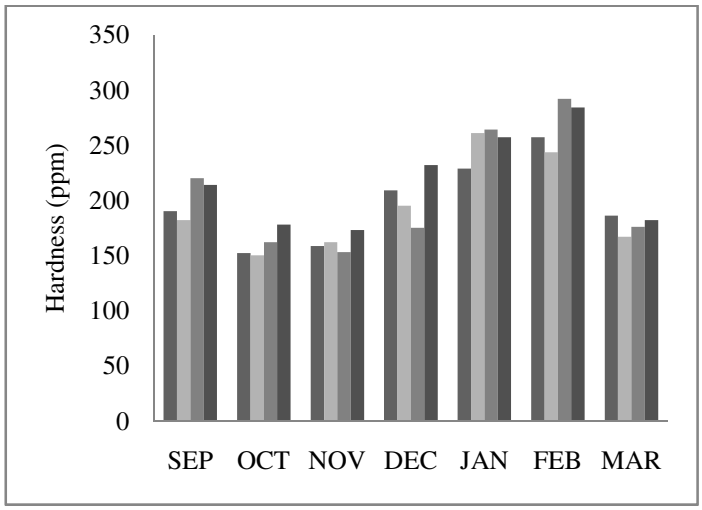

Figure-6: Hardness of Hooghly water collected from four sites.

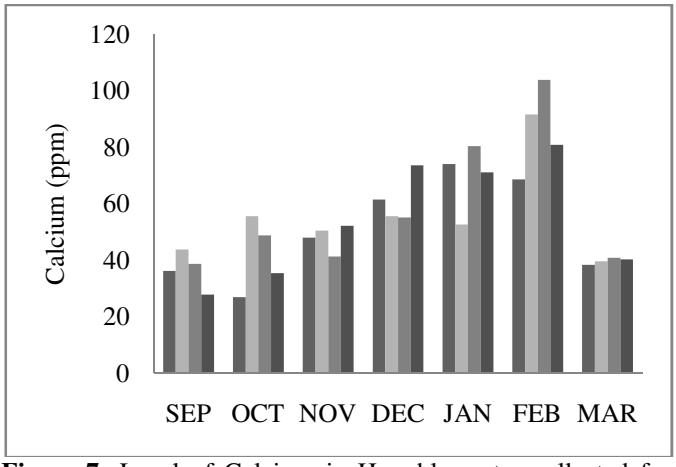

Figure-7: Level of Calcium in Hooghly water collected from four sites.

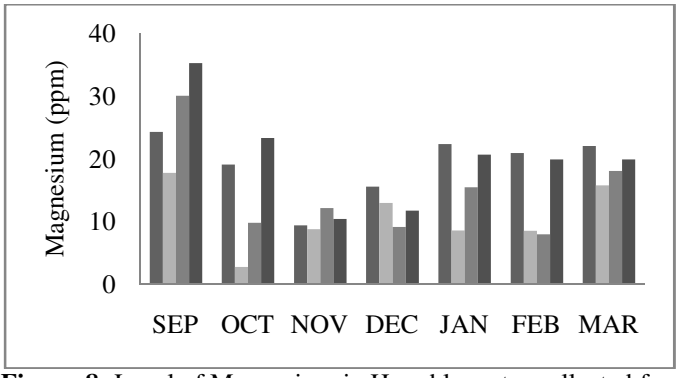

Figure-8: Level of Magnesium in Hooghly water collected from four sites.

The present study revealed that DO was below the normal level i.e. 5 ppm[13]. Seasonal observations also showed similar trend in the study area. Study also revealed a low level of DO in the month of March in all the Stations in comparison to other months. Whereas, during September and October ranged from 1.54 to 2.67 ppm which was increased during the month of November. September and October are post monsoon period and various ritual practices take place during these period in these areas which includes immersion of Goddess Durga and other activities. As a result different inorganic and organic substances are deposited near the bank of the river. Though local municipality takes immediate action to remove all the deposition. But it is quite impossible to clear off all the materials from the water. As a result pollution is under control in Hooghly river water, but not totally removed which was the probable cause of decrease in DO level during that period. The rise in temperature, respiration of biota and decomposition of organic materials reduced the oxygen level in the Ganga water near Kanpur[14]. With advent of season, increase in the growth of algae and phytoplankton raise the photosynthesis rate and DO of water subsequently which was in conformity with Roy[15].

Study also revealed a gradual decrease in DO during January to March in all the sites in comparison to other months. That was probably due to seasonal increase in the activity of coliform bacteria, degrades organic matters by consuming dissolved oxygen and thus decreases DO level during those months indicating organic pollution. Moreover, maximum growth of zooplanktons also takes place during this period, which probably leads to reduce the DO of Hooghly river water as was proposed by Kreutzweiser[16].

Level of Carbon dioxide almost maintained 2 ppm throughout the study period in this region. Statistical analyses revealed a significant inverse relation ($p<0.05$) between DO and free CO_2 (Table-2). CO_2 is highly soluble in water (0.5 $mg.l^{-1}$ at normal 25^oC conditions). Free carbon dioxide can alter pH of the water. Fish may suffer a stress and chance of death is high if the pH drops below 5 or rises above 10. Our study showed an average water pH of 6.49±0.06 and that was probably due to low free CO_2 the water. The low level of free CO_2 is probably due to flowing water and the gas is diffused back into the atmosphere[17]. It was also reported that free CO_2 facilitates the formation of stable bicarbonate and subsequently lowers the carbon dioxide level in the water[18]. That might be the cause of reduced carbon dioxide level in the present study area.

The study revealed that the alkalinity was highest during September that is post monsoon period at all the stations studied. Study also showed moderate range of alkalinity during the winter and reached the lowest level during Spring (March). Phytoplankton and alkalinity have direct relation, as plenty of phytoplanktons increase carbonate and carbon dioxide level by dissociating bicarbonate present in water, which is used in photosynthesis and alkalinity level comes down[19,20]. After monsoon, the level of water reduced and alkalinity of water increase. The alkalinity of water is caused mainly due to stagnancy of water and reduced level of water help in the increase of alkalinity as was observed such variation during the present study[21]. In a similar study, higher alkalinity was recorded due to excess of free carbon dioxide due to decomposition, as the level of river water decrease after monsoon[22]. Such seasonal variation in alkalinity also recorded in river Ganga at Varanasi and in natural water bodies in tropics[23,24]. In MPG, salinity of river water varied from 15.62 to 57.31 mg/l, with an average of 43.911±5.18 mg/l (Table-1). In RRG salinity ranged between 41.18 and 69.5 mg/l (Figure-4). Study also revealed a range of 36.21 to 68.16 mg/l salinity with an average of 51.83±5.34 mg/l at GPG andbetween33.84 and 65.32 mg/l with an average of 54.621±4.1 ppm at DBG was observed. Low salinity was observed during post monsoon period i.e. October in all the stations, except DBG. Then the level increased gradually and maintained a moderate salinity in all the sampling sites. That was probably change in the temperature, evapotranspiration by water as was observed in Adyar river by Govind and Sundaresan[25].

Table-2: Relation between parameters considered during the study.

Sampling Station ----------→	Mangal Pandey Ghat	Ranirashmoni Ghat	Ghatakpara Ghat	Dhobi Ghat
DO- Free CO_2	Y=1.146-0.35x r = 0.7808 t =2.794*	Y=2.38-0.13x r =0.788 t = 2.86*	Y= 2.314-0.11x r =0.777 t = 2.76*	Y=2.194-0.102x r = 0.796 t = 2.94*
Hardness- Ca	Y=18.99+1.74x r = 0.869 t =3.93*	Y=19.64+ 1.34x r =0.553 t = 1.48	Y= 9.6+1.88x r =0.858 t = 3.74*	Y=13.2+1.57x r = 0.77 t = 2.70*

*Significant $p<0.05$

It was also appeared that salinity was higher at DBG in compare to other stations and that was probably due to regular ferry service as well as sewage water released from public toilet and mix with river water of this site. Increasing trend of chloride concentration is contemplated due to mixing of organic wastes of animal origin which is common at DBG. Water with high concentration of chloride or salinity is unpalatable and, therefore, incompetent for drinking and livestock watering. Overall assessment revealed 51.47 ± 2.41 ppm of salinity (Table-1) of Hooghly river water during the present survey, indicated a trend which was within the acceptable limit (IS: 10500:2012). Quite low chloride concentration in river water, reflects that organic waste as well as municipal and industrial wastes were discharged in smaller quantity which was also true for the present study area[18].

Turbidity varied from 36.8 to 125 NTU at MPG, with highest turbidity in March and lowest in January (Figure-5) with an average of 67.53±11.41 NTU (Table-1). In RRG and GPG, turbidity ranged between 30 and 127.3 NTU and 28.3 and 157.3 NTU respectively with low turbidity in January and highest in March and October. In DBG, turbidity ranges between 44.33 and 160 NTU with highest in October and lowest in January. Turbidity was comparatively high at RRG probably due to regular refuge of religious practices and DBG due to ferry services from this station respectively. Overall assessed turbidity (70.378±7.36 NTU) of Hooghly river water during the present survey, indicated a trend, which was above the acceptable limit (IS: 10500:2012). In an almost similar observation Trivedi *et al*.[26] has been reported the turbidity on higher side in all seasons. Turbidity ranged between 30 and 125 NTU during Maha Kumbh-2010 at different bathing ghat of Ganga[27]. So it is appeared from the present study that average turbidity of Hooghly water is higher due to natural causes as well as anthropogenic activities. Because during its long journey from Gangotri to Sagar, river Ganga carries huge amount of silt and also receives industrial effluents, sewage, as well as partly and fully decomposed organic matters. These materials are finally flown through Hooghly river and water in this region is more turbid than the upper stream of the river Ganga.

The present study revealed that hardness of water remains moderate[28] throughout the year, which ranged between 194.35±16.02 and 217.14±16.18 but it was maximum in December to January, then the level was comedown in March (Fig. 6). That was probably due to the low level of water in winter in comparison to summer and monsoon[21]. Lowest hardness was 152 ppm and overall hardness was within the permissible limit as suggested by IS Tolerance limit at the present study area[29]. Study also revealed that Ca and Mg content of river Hooghly were 54.68±3.79 ppm and 16.18±1.23 ppm respectively (Table-1) and comparatively higher than the normal river water as reported previously[30]. Statistical analyses also exhibited a significant relationship ($p<0.05$) between hardness and calcium in all the sites studied (Table-2). Ca also reached highest level during winter probably due to low water level. Such higher level of these two elements probably due to uses of detergents for washing clothes at ghats as well as due to regular disposal of some domestic and industrial effluents in the river water. This was in conformity with Sinha and Das[31] who studied the physicochemical parameters of river Ganges near Patna. Though such disposal is controlled by local Municipality, but it should be stricter and more awareness is required to check all such disposal.

Conclusion

Desolved oxygen had an average of 2.87±0.14 ppm in the study area and maintained a significant relation with the level of free Carbon dioxide. With the variable levels of alkalinity, salinity showed a level, which was within acceptable limit. Hardness of water was moderate throughout the year which had significant relation with the Calcium content of the Hooghly river water. Whereas, turbidity was recorded above the acceptable limit.

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