PATNA WOMEN'S COLLEGE 1940

IRIS
Journal for Young Scientists
ISSN 2278 – 618X **(Print)**
ISSN 2278 – 6384 **(Online)**

http://www.patnawomenscollege.in/journal

Water Quality Analysis of River Ganges at Different Ghats in Patna, Bihar

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Received : November 2017
Accepted : March 2018
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Abstract : *In the present paper, an attempt has been made to analyze the changes from August-September in 2017 on the physicochemical properties of water of the River Ganges at three selected sampling sites i.e. Kali Ghat, Krishna Ghat, Gandhi Ghat. The physico chemical parameters such as Temperature, pH, Turbidity, Electrical Conductivity, Total Dissolved Solids, Dissolved Oxygen, Chemical Oxygen Demand, Biological Oxygen Demand, Chloride and Coliform were evaluated at the selected ghats. It was found that Kali Ghat had the maximum values of EC, TDS, DO, COD, BOD indicating the higher pollution which is attributed to the disposal of untreated sewage and local discharge of wastes.Regular monitoring of the River Ganges water quality is necessary to have a check on surface water pollution for the sake of healthy living of human.*

Keywords : *Turbidity; Electrical Conductivity; Total Dissolved Solids; Dissolved Oxygen; Chemical Oxygen Demand; Biological Oxygen Demand; Chloride; Coliform.*

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Introduction :

Ganges is a trans-boundary river of Asia, which flows through India and Bangladesh. It flows south and east through the Gangetic plains of North India into Bangladesh, where it empties into the Bay of Bengal (Bricker and Jones 1995).

The Ganges River pollution is now at such a high level that the amount of toxins, chemicals and other dangerous bacteria found in the river are now almost 3000 times over the limits suggested by WHO as safe. The river directly and indirectly affects the largest population of any river in the world with over more than 420 million people who rely on it for food, water, bathing and agriculture and that is not to mention the tens of millions of pilgrims who venture to India's most holy of rivers to bathe and worship (CGA 1986; Das 2011).

Approximately, 1 billion litres of raw, untreated sewage are dumped in the river on daily basis. Thousands of bodies are cremated on the banks of the river yearly with many being released into the river with hopes that their souls may have a direct path to heaven (Rai 2013).

The study of different parameters is very important for understanding the metabolic events in the aquatic system. The parameters influence each other. Therefore, it has become obligatory to analyze important water parameters,from time to time, which can indicate the favorable and unfavorable changes occurring in the ecosystem.

Use of DDT was banned in 1989 with a mandate to use a maximum of 10,000 litres/year for the control of vector borne diseases. Most of these chemicals are carcinogenic and adversely affect human health, through the food chain. Increasing numbers of cancer patients in the area where such toxic chemicals are being used, is an indication of the adverse effect of these toxics. All such anthropogenic activities in the Ganges Basin are not only causing a decline in biodiversity in the Basin but the rivers are facing a threat to their very survival (Sinha 2015).

According to the report of the Central Pollution Control Board (CPCB), the capacity of sewage treatment plants is only 70.9% of the total sewage generation (143 MLD) in Patna.

Frequent use of river water by civilians increases the possibility of human health hazards. According to WHO, about 80% of all diseases in human populations are caused by drinking water (CPCB 2006) .The water quality determines the suitability of water usage for various purposes (Ahipathy and Puttaiah 2006). Natural as well as effluent discharges, with the toxic compounds due to anthropogenic activities, cause problems to communities at the receiving aquatic system and has a potential effect on human health (Duruibe et al. 2007). So, in this regard, evaluations of the quality of river water with respect to location along the stretch and in different weather conditions (mainly monsoon season) seem important to prevent the people suffering from diseases and ill health. The quality of river water, as determined by its physical and chemical constituents, is of great importance in determining its suitability for a certain use such as public water supply, irrigation, industrial application etc. (Dwivedi and Pathak 2007).

Many studies have been done on the water quality analysis of different ghats in summer, pre-monsoon and post-monsoon (Rai et al. 2011).

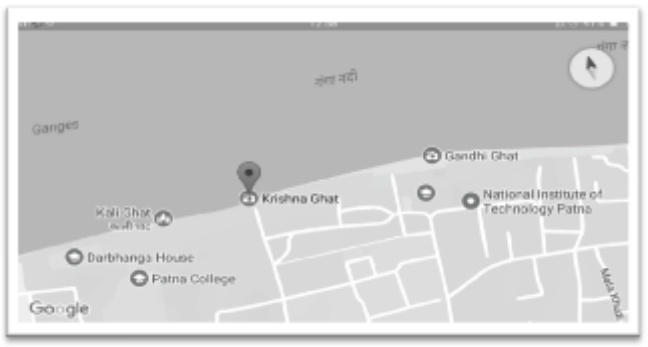
So, in this research project, an effort is made to analyze the water quality of the Ganges.

Therefore, the present study was undertaken to compare the parameters of water of the river Ganges, at the most visited ghats of Patna in the monsoon season.

Materials and Methods :

The present study was confined to the three different ghats of the River Ganges. They were:

LOCATIONS	LATITUDE	LONGITUDE
Kali Ghat	25°37'18"N	85°10'6"E
Krishna Ghat	25°37'19.8"N	85°10'05.8"E
Gandhi Ghat	25°37'20.3"N	85°10'21.1"E



These are the ghats where huge masses of devotees take a holy dip, local people bathe, wash their clothes and discharge local wastes.

Collection of Samples :

Water samples were collected from August-September, 2017, from three selected ghats of the River Ganges. A total of 9 samples were collected for physicochemical analysis of water using polyethylene BOD bottles (1 litre) rinsed with distilled water. Samples were collected from random places of each sampling site and mixed thoroughly. Water samples were stored in the refrigerator to retard the biochemical activities.

Collection of samples took place from 9 a.m. to 12:30 p.m. The samples were analyzed by the standard methods mentioned in (APHA, 2005) and Bureau of Indian Standards for drinking water-specification. Samples were analyzed for the following physicochemical and biological parameters viz.,

PARAMETERS	UNIT	TEST METHODS
Temperature	^{0}C	Thermometer
pH	–	pH Meter
Turbidity	NTU	Turbidometer
Electrical Conductivity	mS/cm	Multitester
Total Dissolved Solids	mg/L	TDS Meter
Dissolved Oxygen	mg/L	Winkler Method with Azide mod.
Chemical Oxygen Demand	mg/L	Winkler Method
Biological Oxygen Demand	mg/L	Winkler Method
Chloride	mg/L	Silver Nitrate Test
Total Coliform	mg/L	Lactose Broth Method

Analysis of Physical Parameters :

The temperature of the water sample was measured with the help of a thermometer.

pH of the water samples were measured by Contech (pH- 102) pH meter.

Electrical Conductivity of the water samples was measured by a Multi tester- Eutech instrument/ ECPCDW65044K.

Turbidity was measured by a Eutech instrument / ECTN100IR (Turbidometer).

Total Dissolved Solids (TDS) was tested by a Systonic TDS meter.

Analysis of Chemical Parameters :

Dissolved Oxygen (DO) of the samples was calculated by Winkler's method with Azide modifications as per IS3025 part 38.

Chemical Oxygen Demand (COD) was calculated by Winkler's method as per IS3025 part 58.

For Biological Oxygen Demand (BOD) calculation, the average values of initial and final readings of DO were taken. The final readings of DO were taken after incubating the water sample at 25p C for 5 days as per IS3025 part 38.

For the chloride test, 2 ml of samples were taken in a test tube and Silver Nitrate ($AgNO_3$) was added. The sample turned white but a precipitate was not formed, hence indicating the presence of chloride ion (Cl^-), but in an insignificant amount.

Analysis of Biological Parameter :

The presence and absence of coliform was estimated by Lactose Broth Method at Global Testing and Research Laboratory, at Jagdeo Path, Patna recommended by APHA.

Statistical Analysis :

The Results are presented as Mean ± SE. The Total variation present in a set of data was analysed through one- way analysis of the variance (ANOVA). The difference between means has been analysed by applying Dunnett's 't' test at 99.9% ($p<0.05$) confidence level.

The calculations were performed with the Graph Pad Prism Programme (Graph Software, Inc., San Diego).

Results and Discussion :

The present study evaluated the physico-chemical status of the River Ganges at Patna at three ghats. The estimation of 8 parameters (Temperature, pH, Turbidity, EC, TDS, DO, COD and BOD) with respect to the Mean ± SE values for surface water quality and their comparison (by ANOVA) among three ghats were summarized in the table.

Table 1.

Physicochemical Parameter Levels at Different Ghats of River Ganges at Patna

PARAMETERS	KALI GHAT	KRISHNA GHAT	GANDHI GHAT
TEMPERATURE (°C)	25.69 ± 1.306*	25.90 ± 1.38*	26.28± 1.35*
pH	7.86 ± 0.315*	8.1 ± 0.370*	8.05 ± 0.379*
TURBIDITY(NTU)	10.47 ± 2.749*	27.42 ± 17.775*	14.18 ± 5.256*
ELECTRICAL CONDUCTIVITY (µS/cm)	271.63 ± 16.936	229.66 ± 4.672	248.53 ± 0.29
TDS(mg/L)	201.4 ± 19.925*	173.3 ± 19.40*	186.56 ± 25.623*
DO(mg/L)	6.93 ± 1.118*	6.733 ± 0.623*	6.8 ± 0.714*
COD(mg/L)	62.26 ± 17.105*	19.1 ± 17.214*	36.76 ± 6.71*
BOD(mg/L)	4.86 ± 0.716*	3.8 ± 0.305*	3.65 ± 0.328*
COLIFORM (CFU/100ml)	PRESENT	PRESENT	PRESENT

(Mean ± Standard error, n=3) $p<0.05$

In the present study, the temperature of the water at Kali Ghat increased by 0.81 % when compared to Krishna Ghat and, when it was compared with Gandhi Ghat, it was found to have increased by 2.29%. These results were significant at $p<0.05$ (Table 1). Similar findings were observed by Trivedi et al. (2010) at Kanpur. Zafer and Sultana (2007) reported monsoon season temperature varied from 25.8°C to 26.1°C.

Table 1 shows that the pH value of Kali Ghat increased by 3.05% when compared to Krishna Ghat, whereas when it was compared to Gandhi Ghat, it increased by 2.41%. These results were found to be significant at $p<0.05$. Similar results were also obtained by Pandey et al. in (2004) at Allahabad, U.P. Prasad and Saxena (1980) observed a pH range 7.2 to 8.5 in the river Gomti. Beg and Ali (2008) and also studied chemical contamination in the river Ganga.

Table 1 shows that the turbidity of the water at Kali Ghat increased by 161.89% in comparison to Krishna Ghat and when compared to Gandhi Ghat, it was found to have increased by 38.29%. The results were significant at $p<0.05$. The present observation finds support with the work of Rai et al. in 2011 at Patna, Bihar.

The Electrical Conductivity of the water at Krishna Ghat was decreased by 15.45% when compared to Kali Ghat, whereas in Gandhi Ghat the EC decreased by 8.50% in comparison with Kali Ghat. These results were not found to be significant at $p<0.05$ (Table 1). Similar findings were also obtained by Srivastava and Sinha (1996) at Allahabad.

Table 1 shows that the TDS of the water at Krishna Ghat decreased by 13.95% from that of Kali Ghat and at Gandhi Ghat it also decreased by 7.36% when compared to Kali Ghat. These results were significant at $p<0.05$.Similar work has also been done by Panday et al. (2014) and Rai et al. (2011) at Allahabad and Patna respectively. Maheswari et al. (2011) recorded that the TDS

varied from 178 to 200 mg/L from the Yamuna River at Agra, India.

In the present study, the DO of the water at Krishna Ghat decreased by 2.84% in comparison to Kali Ghat and when DO of Gandhi Ghat was compared with Kali Ghat, it was found to have decreased by 1.87%. These results were significant at $p<0.05$ (Table 1). Similar observations were seen by Panday et al. (2014) and Singh et al.,(2017). Tripathi et al. (1991) recorded mean value of DO 0.90 at Varanasi. Maheshwari et al. (2011) reported DO varied from 5.5 to 8.2 mg/L from Yamuna River at Agra.

The COD of the water at Krishna Ghat when compared to Kali Ghat decreased by 69.3% and when the COD of Gandhi Ghat was compared with Kali Ghat, it was found to have decreased by 40.95%. These results were significant at $p<0.05$ (Table 1). Tripathi et al. (1991) recorded 520 mg/L COD value at Varanasi. Chandra et al. (2011) reported 22 mg/L at Lucknow from the Gomti River.

Table 1 shows that the BOD value of the water at Krishna Ghat was found to have decreased by 21.81% in comparison to Kali Ghat and, BOD value of Gandhi Ghat when compared with Kali Ghat decreased by 24.89%. These results were found to be significant at $p<0.05$. Similar results were observed by Bhargava, (1987). These results are in conformity with the observation of Sinha et al. (2008) and Janckzyk et al. (2011).

Conclusions :

On the basis of experimental findings, it can be concluded that Kali Ghat had higher pollution than the other two ghats i.e. Krishna Ghat and Gandhi Ghat. Thus may be attributed to increased turbidity, electrical conductivity, TDS, DO, COD and BOD values at Kali Ghat compared to the other two ghats of the Ganges. The parameters, TDS, EC, turbidity and chloride are well within the permissible limits of drinking water recommended by BIS. Higher COD and BOD values and presence of coliform bacteria in all the three sites showed that purification is necessary for domestic consumption for local residents residing near Ghats.

Acknowledgement :

We express our sincere thanks to our respected Former Principal, Dr. Sister Marie Jessie A.C. for giving us the wonderful opportunity to undertake this project and to the research committee of Patna Women's College for facilitating research at undergraduate level and also for allowing us to avail of the facilities of the Central Research Laboratory (CRL), Patna Women's College.

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