

Study of Physico-chemical and Biological Characteristics of the Water of River Ganga at Patna, India

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Abstract

River Ganga arises on the southern slopes of the Indian central Himalayan region beginning the Gangotri glacier. The river covers catchment area of 8, 61,404 km² and its total length in the state Bihar stretch is 475 km. This study was carried out at Patna in the river Ganga at two sampling sites, viz., Digha Ghat (upstream) and Gai Ghat (downstream). The objective of the study was to observe the eminence of water of Ganga at Patna. The results that indicate that the river reaches near the city of Patna (upstream at Digha Ghat) are less polluted with pH 7.75, DO 7.42 mg/l, BOD 2.48 mg/l and COD 15.12 mg/l, while when the river leaves city after travelling 18 km (downstream at Gai Ghat), concentration of all pollutants increases significantly (pH 6.28, DO 6.22 mg/l, BOD 2 mg/l and COD 23 mg/l). The concentration of coliform bacteria (total coliform ranges from 5000 to 6000 MPN/100ml and faecal coliform ranges from 2200 MPN/100ml and 3000 MPN/100ml at both the sites) was recorded at higher level than the upper limit of the permissible level. This increment may be due to domestic and sewage discharge from the city. The municipality of Patna has sewage treatment plant capacity of about 109 MLD but whereas the city generates approximately 250 MLD sewage/township discharge. For the maintenance of pristine quality of water of the river Ganga, the sewage need be treated before discharge.



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Introduction

River is a structure comprising the major route and the tributaries, the flow of which carrying an important load of substance in dissolved and particulate phases as of both natural and anthropogenic sources. The river Ganga is a holy and historic river of India. The river has the largest basin among the rivers covering 26.3% of the entire geographical region of Indian sub-continent. The river Ganga covers 475 km area in Bihar; Patna city is situated on the bank of the Ganga. The Gange calls at the join of Devprayag the Bhagirathi and Alaknanda rivers where the Bhagirathi flows at the bottom of Gangotri Glacier, at Gaumukh. It has total length of 2,525 km. The river rises in the western Himalaya and flows south and east from end to end the Gangetic Plain of North India and terminates in to the Bay of Bengal through Bangladesh. The river is the longest one of India and is the second greatest river in the world by water discharge.¹ Its exciting, socio-cultural, spiritual, and historical repression with Indian culture has given the river Ganga its distinctiveness.

Rivers play an important function in incorporation or transportation of municipal and manufacturing waste water effluent discharge that constitute invariable polluting sources, where surface runoff is a regular phenomena.² Pollution of river is a global problem because these days in view of increasing population, urbanisation and industrialisation, the rivers and the streams are often being treated as

detriment disposal site. Ganga has been reported to turn into a foul-smelling stream extremely polluted with raw sewage, industrial effluents and wastes, or else agricultural runoffs.³ River Ganga carries the maximum silt load of comparatively any river in the world and the deposition of this substance in the delta area consequences in the biggest river delta inside the world 400 km from north to south and 320 km as of east to west.⁴

This study carried out in the month of May to June, 2014 to the physico-chemical and biological distinctiveness of water quality of river Ganga at Patna at two different sites.

Materials and Methods

Study Area

The present study was completed after selecting two sampling sites along the right bank of river Ganga, viz., Digha Ghat (upstream; latitude 25°39'04.15" N and longitude 85°06'28.49" E) and Gai Ghat (downstream; latitude 25°36'43.00" N and longitude 85°12'35.71" E), during May to June, 2014.

The altitude of the study area ranges from 44.2 to 50.3 meters asl. Patna district had the total population 5,838,465 and population density 1,823 people per km² recorded.⁵ Patna town is the capital of Bihar and situated lying on the south bank of the river Ganga. A feature of the geography of Patna is its convergence of rivers of Ganga and Gandak at downstream. Uniqueness of Patna is having four



Fig.1: Location map of sampling sites beside the right bank of river Ganga at Patna. The study sites are: Digha Ghat (upstream) and Gai Ghat (downstream).

large rivers in its surrounding area and also it is the prime riverine city in the world. Patna has a humid sub-tropical climate. Temperature ranges from 47°C uppermost in summer to 1°C lowly in winter, and annual rainfall is recorded approximately 1100 mm. Weather conditions are characterize by hot and dry summer starting March to June and cold winter starting November to February where as the humidity is high starting July to September with average annual humidity approximately 72%.

Collection of Water Samples

The sub-surface water samples of the river Ganga were collected as of two sampling sites referred above during same day and carried to the laboratory for analysis. Water samples were stored and preserved without delay inside acid-cleaned polypropylene bottles during frozen condition using transportable ice box to reduce the biogeochemical alterations as per standard procedure.⁶ Water samples were collected at the interval of seven days during May to June, 2014 and kept in refrigerator at 4°C in the laboratory for experiment.

Water Analysis Process

The study was undertaken at two sampling sites: Digha Ghat (upstream) and Gai Ghat (downstream) along an 18 km stretch of river Ganga. Following the Standard method (APHA 1995) water samples were collected for analyzing pH, electrical conductivity

(EC), total hardness (TH), total dissolved solids (TDS), chloride (Cl), dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), faecal coliform (FC) and total coliform (TC) bacteria. Some variables (pH, DO and EC) were analyzed at the sampling station just after sampling and other parameters were analyzed in the laboratory of Bihar State Pollution Control Board, Patna. There were used standard methods. Water samples were bringing to the laboratory inside the ice boxes. Total DO was analyzed by using water analyzer electrode, total hardness through EDTA titrimetric method, BOD₅ was analyzed by the titration methods, COD through dichromate reflux method, chloride by argentometric method by Potassium chromate as indicator, and total coliform and faecal coliform by MPN method.

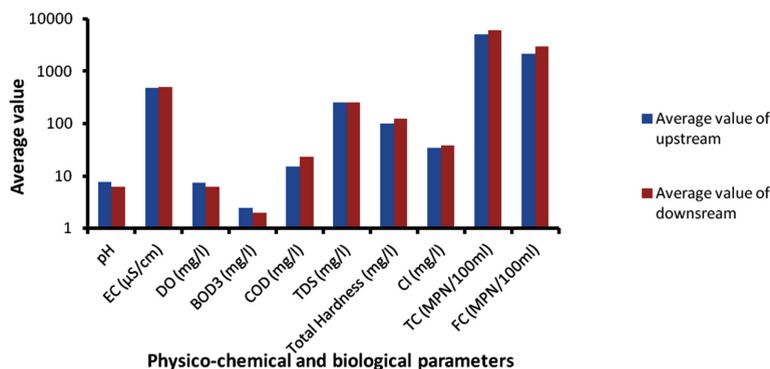
Results

Physico-chemical and biological characteristics of the river water samples at the study sites are shown in Table 1. The majority of the chemical and biochemical reactions were influenced with the pH. The pH value was maximum (7.75) at upstream and minimum (6.28) at downstream. The value of EC was maximum (499.25 $\mu\text{S}/\text{cm}$) and minimum (487.2 $\mu\text{S}/\text{cm}$) at downstream and upstream, respectively. The DO values were observed maximum and minimum 7.42 and 6.22 mg/l at upstream and downstream

Table 1: Physico-chemical and biological attributes of water of river Ganga at Digha Ghat (upstream) and Gai Ghat (Downstream) in Patna

Sampling Site	Variable										
	Mean	pH	Cond. ($\mu\text{S}/\text{cm}$)	DO (mg/l)	BOD ₅ (mg/l)	COD (mg/l)	TDS (mg/l)	Total Hardness (mg/l)	Cl (mg/l)	Total Coliform (MPN/100ml)	Faecal Coliform (MPN/100ml)
Digha Ghat (upstream)	Mean	7.75	487.25	7.425	2.475	15.125	250.25	100.5	35.05	5001.5	2200.25
	Min.	7.5	484	7.3	2.4	15	250	100	35	5000	2200
	Max.	8	490	7.5	2.5	15.4	251	101	35.1	5005	2201
	SD	0.29	3.20	0.10	0.05	0.19	0.50	0.58	0.06	2.38	0.50
Gai Ghat (Downstream)	Mean	6.275	499.25	6.225	2.05	23.025	254.5	126.25	38.25	6006.25	3002.5
	Min.	6	498	6	2	23	254	125	38	6000	3000
	Max.	6.5	500	6.5	2.1	23.1	255	128	38.5	6009	3005
	SD	0.26	0.96	0.26	0.06	0.05	0.58	1.26	0.29	4.19	2.38

SD= Standard deviation



Graph 1. Average value of physico-chemical and biological parameters of water quality of upstream and downstream of river Ganga at Patna

sampling sites respectively. It has been used as determine of the quantity of organic materialism a water solution which supports the growth of microorganism.⁷ The values of BOD were observed maximum and minimum 2.48 and 2.0 mg/l at upstream and downstream sites, respectively. COD decides the quantity of oxygen requisite for chemical oxidation of organic matter with a strong chemical oxidant like potassium dichromate beneath reflux conditions.⁸ The COD mean value varies from 23 mg/l to 15.12 mg/l at the study sites.

Total dissolved solid (TDS) depend on different factors, such as, geological nature of quantity of surface runoff, rainfall and watershed, and gives an sign of the degree of liquefied substances.⁹ The mean values of total solids were observed maximum (254.5 mg/l) and minimum (250 mg/l) at downstream and upstream, respectively. Hardness of water may due to natural accretion of salts from get in touch with soil and geological formations or it might enter from direct pollution through industrial discharge. The value of total hardness ranged from 126.2 mg/l to 100.5 mg/l at downstream and upstream respectively. Chloride is one of the most important inorganic anion inside water and waste water. The most significant source of chloride in the water is the discharge of domestic water.¹⁰ The chloride content was highest (38.25 mg/l) and lowest (35 mg/l) at downstream and upstream, respectively. The total coliform counts were observed maximum and minimum, 6006.25 and 5001.5 MPN/100 ml, respectively, at downstream and upstream. Faecal coliform is a part of the total coliform group which

is of faecal origin. The faecal coliform values were maximum and minimum 3002.5 and 2150 MPN/100 ml at downstream and upstream, respectively.

Discussion

By Fakayode (2005)¹¹, the pH of a water sample is very significant in determination of water quality given that it affects further chemical reactions, such as, easily dissolving and metal toxicity. The pH values were found to be slightly alkaline at upstream, which dropped to an acidic at downstream. The water at the sampling sites could, therefore, be considered as polluted. Conductivity is an excellent and quick method to determine the total dissolved ions and is directly related with total solids. Conductivity and total dissolved solids were found more or less similar at both the sites.

The chloride content were found maximum (38.5 mg/l) at downstream. The total hardness of the constraint of water quality used to illustrate the consequence of dissolved minerals. In the present study, it was found maximum at downstream. The auto-purifying capability of the river Ganga is derived from its curiously high capacity to maintain dissolved oxygen inherited from this environment. Lack of adequate DO leads to infected condition and increases BOD in the river.³ The DO is also an imperative limnological factor representing level of water eminence and organic pollutants in the water body.¹² It was found low in downstream. The BOD was high at upstream and minimum at downstream, where the COD was maximum at downstream only.

Urbanization and population sudden increase due to industrial development and infrastructure enlargement in India lead to most of the region faces to stress on water resources.¹³

The total coliform and faecal coliform is very important parameter to determining river water quality; these were found undesirable at downstream. It appears from the result that when the river enters to the city (upstream), it is less polluted; all the pollutants are in low concentration. While when the river leaves city (downstream), concentration of all the pollutants increases remarkably. This increment may be because of domestic and sewage discharge. Downstream the river Ganga converted black and infected, and ripples are frothy at several places, emitting methane bubbles, with floating untaken bodies of the dead, corpses of animals, partially cremated remnants of the babies and relic waste thrown to the river to attain eternal peace, floral offerings, garlands and refuse.³

Conclusion

Systematic and comprehensive analysis with incorporation of biological methods, samples to elucidate the local factors shows that impact of untreated sewage is increasing in the river Ganga. The elevated level of bacteriological population makes the surface water unsuitable for consumption

which may cause depletion of dissolved oxygen in it. The major source of pollutions contributed by the heavy discharge of sewage from municipality of Patna. The surface water require treatment earlier than its consumption; suitable water treatment process such as water softening, ion exchange and demineralization may be used to decrease the concentrations of contaminants. Finally, these finding showed the importance of understanding the water characterization for effective utilization and prediction of change to minimize the effect of urbanization. It is essential to safeguard the utilization and monitoring after three months of water resources for future generations.

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