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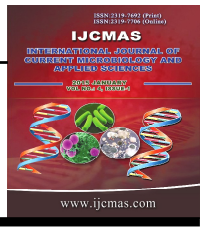

Original Research Article

Effect of temperature and distance on physico-chemical and biological parameters of Ghaggar river water, India

N.Khan*, A.Kumar, V.Sharma and U.Farooq

Department of Microbiology, Shoolini University of Biotechnology and Management Sciences, Solan, H.P., India
**Corresponding author*

A B S T R A C T

In the present investigation water samples were collected from Panchkulla during February and March 2010 at the interval of 15 days from 5 different sites each at 50 m distance to check the effect of distances and temperature on river water. Effect of temperature and distance was studied on the physico-chemical parameters which include temperature and turbidity, pH, total solids, Ca^{2+}, alkalinity, BOD, COD and the inorganic constituents (Magnesium and Sulphite). The Biological parameters were total bacterial count, coliform count. Seasonal variation of some parameters was observed i.e. values of some parameters like Electrical conductivity 0.54 (minimum) to 0.67 (maximum) was highest during summers and decreased in winters. Bacterial count of water samples was minimum 44×10^7 at lowest temperature and consistently it increased with temperature and reached maximum 185×10^7. Some parameters like DO and alkalinity were decreased with increase in temperature i.e. 5.9 mg/l (minimum) and 7.4 mg/l (maximum) respectively. Alkalinity was ranged between maximum 179 mg/l to minimum 99.9 mg/l. Some parameters were also affected with distance. Concentration of contaminants was minimum at point before contamination, highest at point of contamination and then decreased with increase in distance. The study suggested that the Quality of water of river Ghaggar become deteriorated in this area because of effluent discharge and unhygienic personal practices. The frequent effluent discharge in river Ghaggar should be stopped or discharged after proper treatment.

K e y w o r d s

Physico-chemical parameters, Biological parameters, Ghaggar River

Introduction

The river Ghaggar situated in Northern part of India is a main seasonal river. The Ghaggar rises in the Shivalik Range, northwestern Himachal Pradesh , and flows about 200 miles (320 km) southwest through Pinjore in the state of Haryana, where it receives the Saraswati River.

It rises up in the outer Himalayas between the Yamuna and the Satluj. It is passing through Ambala and Hissar and it reaches Bikaner in Rajasthan and runs a course of 290 miles before finally disintegrating in the deserts of Rajasthan. River water is one of the prime sources of fresh water. Rivers are

best water ways of strategic importance across the world, providing main water resources for domestic, industrial and agricultural purposes (Faith *et al*., 2006). They are prime factors controlling the global water cycle and in the hydrologic cycle, they are the most dynamic agents of transport (Garrels *et al*., 1975), but in 21st century our natural water resources have been used unconsciously which leads to it's over exploitation.

Water pollution is increasing steadily and the problem of water quality deterioration is mainly due to human activities such as disposal of dead bodies, discharge of industrial and sewage wastes and agricultural runoff which are major cause of ecological damage and pose serious health hazards (Meitei *et al*., 2004). River pollution in India has now reached to a critical point. It is estimated that community waste from human activities accounts for four times as much wastewater as industrial effluents (Sahu *et al*., 1993).

Various factors which play an important role for the growth of flora and fauna in water body viz. temperature, turbidity, nutrient, hardness, alkalinity and dissolved oxygen and biological oxygen demand indicates the pollution level of the water body (Kamal *et al*., 2007).

Water pollution is also affected by temperature and distance. Summers provides optimum temperature for growth as compared to winters and the concentration of pollutants are high at point of contamination. The present study was aimed to investigate the water of River Ghaggar because at downstream sites various point and non-point sources are joining the Ghaggar River and discharging their untreated effluents into it, because of this water quality of river Ghaggar is deteriorating day by day. It is very important to analyze water quality in routine to protect our natural water resource.

Materials and Methods

Study site

Panchkulla city in Haryana state of India is situated on the bank of river Ghaggar in the foot Hills of Shivalik mountain range of Himalaya. The area under investigation lies between North 30^{o}44N Latitude 76^{o}48E Lon gitude.

Collection of Water Samples

Water samples were collected from 5 different sites each at 50 m distance. 1 lt water samples were collected aseptically as we have earlier described in Khan *et al*., 2014.

Analysis of physico-chemical and biological parameters

Physico-chemical and biological properties of water samples were measured and described previously in Khan *et al*., 2014. In the present study we have compared all these physico-chemical and biological parameters viz. temperature, pH, conductivity, turbidity, TS, TDS, TSS, salinity, alkalinity, total hardness, calcium, chloride, magnesium, sulphite according to effect of temperature and distance.

Results and Discussion

Physico-Chemical analysis

A large number of factors and geological conditions influence the physico-chemical parameters of water samples directly or indirectly. Various physico-chemical and biological properties were studied and

reported in our previous publication in Khan *et al*., 2014 to evaluate variations in surface water quality of River Ghaggar.

In the present study we have compared all these parameters according to effect of temperature and distance. Different parameters were studied and compared with standard values provided by world health organization.

In the present study, we have observed seasonal variation in temperature of water samples; it was ranged between 18^0C to 32^0C at the time of collection (Table 2). We could not observe the effect of distance on temperature. The temperature of water samples was same at different sampling sites. The rising of temperature was observed from February to March.

During this period the season has been changed from spring to summer and the temperature of weather increases, which directly affect the temperature of flowing water. The rise in temperature of water accelerates chemical reactions, reduces solubility of gases, amplifies taste and odour and elevates metabolic activity of organisms (Usharani *et al*., 2010).

Hence the changes in temperature of weather directly proportionate the temperature of water. Temperature showed significant positive correlation with Cl and also showed slight positive correlation with electrical conductivity (EC), biological oxygen demand (BOD) and chemical oxygen demand (COD), and significant negative correlation with pH.

The pH of aquatic system is an important indicator of the water quality and the extent of pollution in the watershed areas. In the present study pH of water samples was recorded. We have observed pH from 7.3 (minimum) to 8.2 (maximum) (Table 2). It has been reported that the increasing pH of water associated with increasing use of alkaline detergents in residential areas and alkaline material in industrial areas (Kumar *et al*., 2011). The effect of temperature on pH was not observed, while the variation in pH of water samples was found in between the samples collected before the point of contamination and after the point of contamination. The variation in pH of water samples may be due to the presence of chemical pollutants adding at the point of contamination, which may be acidic or basic. This is in accordance to the study reported by Kumar *et al*., 2011.

In the present study the Electrical conductivity was recorded as 0.54dS/m(minimum) to 0.67dS/m (maximum) in concern of temperature, we have observed that conductivity decreased with increase in temperature (Table 2). So conductivity is inversely proportional to temperature. The conductivity was minimum 0.48dS/m at point before contamination and 0.66dS/m at point of contamination, again it decreased with increase in distance (Table 3), we have observed that conductivity decreased with increase in distance. Conductivity is directly related to amount of ions i.e. total dissolved solids, higher the value of conductivity, greater the value of ions and higher will be the dissolved solids (Chang *et al*., 2008). This is in accordance to the study reported by Kumar *et al*., 2011.

The Dissolved Oxygen (DO) was recorded as 5.9mg/l (minimum) and 7.4mg/l (maximum) respectively (Table 2). So concentration of DO decreased with increase in temperature. DO is inversely proportional to temperature. In case of distance, DO was minimum 1.7mg/l before contamination point and maximum 8.7mg/l at point of

contamination, with increase in distance DO was decreases (Table 3). The Dissolved Oxygen (DO) is very important parameter in determining the water quality of an aquatic system, because the rates of respiration and organic decomposition are increased where anthropogenic wastes are high and the rate of photosynthesis is also increased and with this the DO values usually remain lower (Bhatt *et al*., 1999).

Similar results were found with Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). BOD is a measure of the increased amount of oxygen in the water that is required by the aerobic organisms for biodegradation of organic materials. Because of Increased microbial load there is increase in the oxygen demand, which is further responsible for increase of BOD (Mishra *et al*., 2009).

COD was commonly used to measure the amount of organic compounds in water? The amount of COD is directly related to quantities of organic matter found in water. COD is a useful indicator of organic pollution in surface water (Abida *et al*., 2008). Higher the value of COD higher will be the organic compounds in water. This is in accordance to the study reported by Kumar *et al*., 2011.

Alkalinity was ranged between maximum 179 mg/l to minimum 99.9 mg/l, alkalinity decreases with increase in temperature (Table 2). Alkalinity is inversely proportional to temperature. In case of distance alkalinity was minimum 83.1 mg/l before point of contamination and maximum 164.4 mg/l at point of contamination and then it decreases (Table 3).

Alkalinity of water samples is mainly a parameter used to measure the amount of weak acids present in water samples and the number of cations balanced against these weak acids (King *et al*., 2003). Total alkalinity of water samples depends upon presence of mineral salt i.e because of the carbonate and bicarbonate ions present in water samples (Sverdrap *et al*., 1942). This is in accordance to the study reported by Kumar *et al*., 2011.

In case of total hardness there was no consistency for temperature and in case of distance this parameter goes like other parameters i.e. minimum 418.4 mg/l and maximum 914.8 mg/l, this value decreases with increase in distance (Table 2). Total hardness is a very important parameter of water quality used to determining suitability of water for domestic, industrial and drinking purpose. It's directly related to presence of bicarbonates, sulphates, inorganic and organic constituents of water (Sing *et al*., 2010). The concentration of calcium, chloride was maximum 198.8 mg/l, 126.7 mg/l and minimum 138.4 mg/l, 71.1 mg/l respectively, value of calcium decreases with increase in temperature (Table 2).

The chloride in water samples is appeared to be mainly due to sewage contamination and fecal contamination (Taylor *et al*., 1949). Concentration of calcium and chloride was maximum 72.3 mg/l, 92.7 mg/l and minimum 180.4 mg/l, 96 mg/l respectively.

Concentration of calcium and chloride was minimum at point before contamination and maximum at point of contamination consistently it decreases with increase in distance (Table 3). Seasonally, the values were highest during summer followed by winter season; similar findings were also reported by Tiwari, 1983; Sikandar, 1987 and Shukla *et al.*, 1989 in Varanasi.

Table.1 Number and time interval of the water samples collected from different sites of river Ghaggar

Sampling time	**Sampling Sites**					**Total no. of Samples Collected**
3-02-2010	S_1	S_2	S_3	S_4	S_5	5
18-02-2010	S_1	S_2	S_3	S_4	S_5	5
15-03-2010	S_1	S_2	S_3	S_4	S_5	5
1-04-2010	S_1	S_2	S_3	S_4	S_5	5

Table.2 Effect of temperature on physico-chemical parameters of Ghaggar river water

Physico-chemical Parameters	**Sample 1 (03-02-2010)**	**Sample 2 (18-02-2010)**	**Sample 3 (05-03-2010)**	**Sample 4 (21-03-2010)**
Temperature	18^0C	20^0C	26^0C	32^0C
Conductivity (dS/m)	0.67±0.008	0.64±0.003	0.76±0.005	0.54±0.034
Turbidity(NTU)	42.8±9.5	40.2±11.86	30.8±9.41	23.6±8
pH	7.5±0.23	7.7±0.27	7.7±0.33	7.62±0.36
Salinity(mg/l)	0.42±0.044	0.36±0.089	0.40±0.173	0.38±0.109
TS(mg/l)	502.5±155	492±189	469.6±138	443.2±193
TDS(mg/l)	410±137	376.6±156	382.1±119	348.5±155
TSS(mg/l)	92.4±19.05	97±22.20	87.5±19.41	90.68±21.91
Alkalinity(mg/l)	179±40.85	174±49.44	118.2±28.47	106±26.81
Total Hardness(mg/l)	762.6±14	737±12.2	798.6±16.3	816.2±13
Calcium(mg/l)	198.8±40.68	173.48±62.14	168.6±40.26	138.5±34.07
Chloride(mg/l)	126.7±28.56	131.08±30.65	79.2±15.91	71.16±19.23
Magnesium(mg/l)	6.2±1.69	6.16±1.82	7.4±2.46	6.34±2.57
Sulphite(mg/l)	1.72±0.63	1±0.473	2.0±0.305	1.66±0.981
D.O(mg/l)	7.52±2.91	7.08±3.11	7.0±3.08	5.96±2.68
BOD(mg/l)	11.95±5.31	14.13±7.47	14.10±6.79	15.64±7.27
COD(mg/l)	22.48±11.89	28.04±11.57	26.4±11.84	27.16±9.95

Table.3 Effect of distance on physico-chemical parameters of Ghaggar river water

Physico-chemical Parameters	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
Conductivity(dS/m)	0.48±0.24	0.66±0.45	0.65±0.34	0.65±0.42	0.65±0.39
Turbidity(NTU)	17±7.2	39.75±9.6	39±9.2	38.25±9.7	37.0±10.13
pH	7.25±0.17	8.0±0.15	7.8±0.14	7.7±0.09	7.5±0.10
Salinity(mg/l)	0.22±0.12	0.45±0.06	0.45±0.06	0.42±0.05	0.40±0.00
TS(mg/l)	193.4±69.0	616.5±26.1	579±53.1	521.3±8.22	474±26.9
TDS(mg/l)	137.7±57.1	489±53.3	446±44.81	428.4±5.68	395.5±27.1
TSS(mg/l)	63.9±3.7	114.3±6.13	108±5.88	92.3±3.95	81±7.25
Alkalinity(mg/l)	83.15±17.6	169.4±33.7	162.7±36.41	157.6±50.81	148.7±51.8
Hardness(mg/l)	418.5±73.4	918.8±63.0	898.4±70.5	837.8±53.1	798.8±43.24
Calcium(mg/l)	92.3±27.02	196.1±22.2	191.6±21.5	188.6±29.4	180.5±37.17
Chloride(mg/l)	72.95±4.79	123.4±27.9	114.3±34.9	103.7±41.2	96.0±48.3
Magnesium(mg/l)	2.7±0.66	6.5±3.59	6.05±3.36	5.97±3.11	5.62±3.12
Sulphite(mg/l)	0.65±0.66	2.17±0.67	1.67±0.51	1.77±0.25	1.77±0.25
D.O(mg/l)	1.7±0.50	8.7±0.96	8.5±0.78	8.0±0.56	7.4±0.62
BOD(mg/l)	2.5±1.33	18.7±1.38	17.5±1.87	16.7±1.66	14.2±3.65
COD(mg/l)	12.2±1.27	37.9±2.04	34.2±4.43	27.5±5.68	18.2±6.24

Table.4 Effect of temperature on biological parameters of Ghaggar river water

Biological Parameters	**Sample1**	**Sample 2**	**Sample 3**	**Sample 4**
Plate Count	44×10^7	62×10^7	176×10^7	185×10^7
MPN Index/100ml	671	714	999	1250
Membrane Filtration (No.of coliform/100ml)	65	70	72	78

Table.5 Effect of distance on biological parameters of Ghaggar river water

Biological Parameters	**S 1**	**S 2**	**S 3**	**S 4**	**S 5**
Plate Count	40×10^7	181×10^7	118×10^7	118×10^7	80×10^7
MPN Index/100ml	340	1600	1255	897	450
Membrane Filtration (No.of coliform/100ml)	57	87	82	67	61

Biological analysis

Biological analysis of water samples showed that bacterial count of water samples was minimum 44×10^7 at lowest temperature and consistently it increased with temperature and reached maximum 185×10^7 (Table 3).

In case of distance bacterial count was minimum 40×10^7 before point of contamination and maximum 181×10^7 at

point of contamination then consistently it decreases with increase in distance (Table 4). Bacterial count is a direct measure of contamination because increased load of microorganisms is directly correlated to contamination. The MPN number was minimum 671 at lowest temperature and it increased with temperature and reached maximum 1250 (Table 4). Similarly with other parameter MPN number was also minimum i.e. 340 before point of contamination and maximum 1600 at point of contamination then it decreases with increase in distance (Table 4).

Number of coliform count was minimum 65 and increased with increase in temperature and reached maximum i.e 78 (Table 3). In case of distance coliform count was minimum 57 before contamination point and maximum 87 i.e. at point of contamination; again it decreases with increase in distance (Table 4). Presence of coliform in water samples is a direct indicator of fecal contamination of water. Similar Biological properties were also studied by Puyate *et al.*, 2008.

In the present study all these parameters are compared with standard values of world health organization and all parameters are higher as compared to standard one, so it was concluded that Ghaggar River water is not suitable for drinking purpose. The chemical and biological characteristics of a river system are indicative of the quality of the water. Conversely, the quality of the water dictates the kinds of plants and animals that will live there. Nutrient overloading from agricultural practices and shoreline development can result in a dramatic change in water quality. Pesticides and other chemicals can also be devastating as well as increased fecal coliform bacteria affect public health. Considering all these points it is necessary to monitor water quality parameters regularly.

Recommendations

- Periodical monitoring of river water is necessary to protect our natural water system.
- Human contaminants such as fecal matter, industrial and agricultural wastes should be kept away from water resources.
- Results of present study showed that with increase in distance from effluent discharge and unhygienic personal practices the load of pollutants decreased, so we should avoid using water from these areas.
- There is a great increase of microbial load in summer as comparison to winter, so special care should be taken during summer.
- Public awareness is required to save our natural water resources.

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