Research Article

Ghaggar River: Impact of Polluting Agents and Microbial Components in River Water

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ABSTRACT

Ghaggar, one of the major rivers of northern India originating in outer Himalayas and flowing through the state of Punjab, Haryana and Rajasthan, is put to multiple uses. Because of Geological changes it now dries up in Rajasthan. Along its course of 464 km, it receives discharge from various cities and runoff from agricultural lands. In this study we present an extensive investigation of Physico-chemical and Biological parameters of water samples of Ghaggar River, Haryana. Water samples under investigations were collected from Panchkulla during February and March 2010 at the interval of 15 days from 5 different sites each at 50 m distance. The Physico-chemical parameters include temperature and turbidity, pH, total solids, Ca^{2+}, alkalinity, BOD, COD and the Inorganic constituents (Magnesium and Sulphite). The major Biological parameters studied were Total Bacterial Count, Coliform Count. All these are most significant parameters contributing to water quality variations and are responsible for water quality variations were compared with standard values provided by World Health Organization (WHO). We have observed that the values of different parameters viz. Total Bacterial Count, Coliform Count) were high in comparison to standard values. The microbial pathogens like *E. coli, Salmonella, and Pseudomonas* have also isolated from the water. 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 of sanitary discharge in river Ghaggar should be stopped or discharged after proper treatment.

Keywords: Biological parameters, Ghaggar River, Physico-chemical parameters.

INTRODUCTION

Water is surely God's greatest gift to mankind. Water is required to sustain the life on earth. It covers 71% of the earth surface. Oceans hold 97% water, 1.6% water is below ground, 2.4% as glaciers and 0.001% in the air as vapours and clouds.[1] Water pollution by chemicals and biohazards is a major problem which causes changes in the physical, chemical and biological conditions of water which creates hazardous conditions in environment and disrupts the balance of the ecosystem of water. Unpolluted water contains organic as well as inorganic compounds and some microbes to such a small extent that it does not affect human health. The water has been polluted by domestic and industrial wastes. Various pollutants such as carbon dioxide, ammonia, suspended solids, variety of inorganic substances, some toxic materials are responsible for water pollution.[2] Human activities are also a major factor for deterioration of the quality of surface and ground water through atmospheric pollution, effluent discharges, use of insecticide and pesticides in agriculture at large scale may pollute soil and lands .[3] Polluted water is really very dangerous for aquatic as well as human life. World health organization (WHO) has been reported that 80% of the diseases are due to unhygienic condition and unsafe drinking water.[4]

The present study was aimed to investigate the water of River Ghaggar, an important river of Haryana state situated in northern part of India, this river originated from outer range of mountain Himalaya. The Ghaggar, a major river of Haryana originates from the Shiwalik Hills of Himachal Pradesh and Haryana. The Ghaggar River flows from east to west and then takes a south westerly course. During its westward journey, a number of streams, streamlets, drains and tributaries debouch their load into the Ghaggar. After flowing through Morni Hills before entering the plains, the Ghaggar River is joined by the Kaushalya Nadi in the foothills zone. This river is very important for agricultural purposes as well spiritual values. The small streams viz. Kaushalya, Jhajra and Ghaggar get combined together near Chandimandir to form the main Ghaggar River. Further, at downstream sites various point and non-point sources are joining the Ghaggar River and discharging their untreated effluents into it.

MATERIALS AND METHODS

Selection of 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°44N Latitude 76°48E Longitude.

Collection of sample

The samples were collected in plastic canes which were thoroughly washed thrice with water to be analyzed. The samples were collected by keeping and opening the mouth of containers. Samples were collected from five different points which were identified and having 50 m distance. Then the samples were transported to the laboratory for detailed analysis for Physical, chemical and

Biological properties. A total of 20 samples were collected from each point fortnightly during the month of February to March 2010 (Table 1). All the samples were analyzed within 2-4 hour of collection. In case of delay, the necessary steps were taken to ensure the biological activity as given in standard methods as described by American Public Health Association.[5]

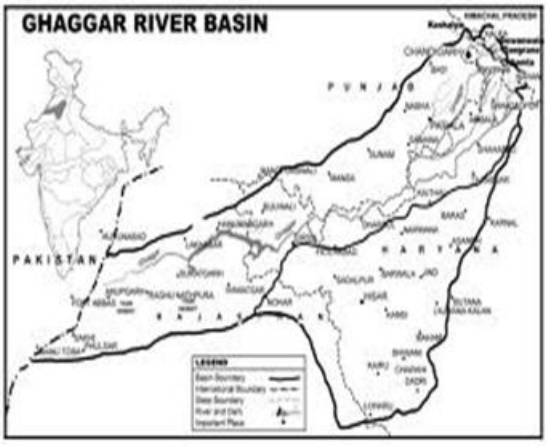

Table 1: Showing the number and time interval of the collection of water samples from five different points of River Ghaggar, (n=20)

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
5-03-2010	S_1	S_2	S_3	S_4	S_5	5
21-3-2010	S_1	S_2	S_3	S_4	S_5	5
Grand Total						20 samples

Analysis of Physico-Chemical parameters

Physical and Chemical analysis of water samples were measured as described by APHA, 1998.[6] some of physico-chemical characteristics were analyzed at the site like pH, temperature. In Physical parameters colour of water samples were identified by visualization. Temperature of samples was analyzed by thermometer. Conductivity, turbidity, salinity, alkalinity, pH of water samples were analyzed by water analyzer. All other Physical and Chemical analysis like, Analysis of Hardness, Calcium, Chloride, Magnesium, Sulphite, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) were done as described by APHA, 1998 .[6]

Analysis of Biological Parameters

Biological Parameters were analysed by Plate Count Method, Multiple-tube Most Probable Number Method as described by APHA, 1998.[6] for characterization of isolated micro flora, morphological and cultural characterization of bacterial isolates was done as described by Aneja, 2006.[7] Isolates were grown on Nutrient agar for bacterial cultures and Potato Dextrose agar for fungal cultures. Selective media were used to characterize different bacterial isolates. Isolates were Gram stained and observe microscopically for identification. For confirmation biochemical analysis of bacterial isolates was done as described by Robin *et al*., 2003.[8] Fungal isolates were further characterized in terms of cultural, morphological characteristics of mycelium and hyphae with the help of staining and then identified on the basis of specific characteristics on Potato Dextrose Agar.

RESULTS AND DISCUSSION

Physico-Chemical analysis

A large number of factors and geological conditions influence the correlations between different pairs of Physico-chemical parameters of water samples directly or indirectly. In the present study, various Physico-chemical and biological properties were studied to evaluate variations in surface water quality of Ghaggar River. Physical and chemical properties of water samples were highly affected by contaminants. Samples were collected from five different points which were identified and having 50 m distance at time interval of 15 days. Different parameters were studied and compared with standard values provided by W.H.O. Values of physical parameters like conductivity was ranges between 0.48 dS/m to 0.66 dS/m and Turbidity was 17 mg/l to 39 mg/l as shown in Table 2. Chemical characterization of water samples is shown in Table 3, values of different parameters like pH was ranges from 7.2 to 7.8, Salinity was 0.2 mg/l to 0.4 mg/l, TS was 193 mg/l to 616 mg/l, TSS was 64 mg/l to 108 mg/l, TDS was 297 mg/l to 489 mg/l, Alkalinity was 83 mg/l to 169 mg/l, Total Hardness was 418 mg/l to 915 mg/l, Calcium was 92 mg/l to 196 mg/l, Chlorine was 73 mg/l to 123 mg/l, Magnesium was 3 mg/l to 8 mg/l, Sulphite was 0.6 mg/l to 2.1 mg/l, BOD was 2.5 mg/l to 18.1 mg/l, COD was 12.2 mg/l to 38 mg/l. All these values were increased as compared to standard values. Similar findings have been reported by Tiwari (1983), Sikandar (1987) and Shukla (1988). It was observed that maximum of the samples exceeded the prescribed limit of maximum parameters. Samples showed high concentration or value of some of the sensitive parameters like temperature, calcium, BOD, COD and pH. There was no consistency in the particular characteristics. Physical parameters like conductivity and turbidity decreases with increase in temperature. Values of some chemical parameters like pH, BOD increases with increase in temperature. Other parameters like TS, TSS, DO decrease with increase in temperature. Chemical parameters like alkalinity, sulphite, and magnesium had showed fluctuating values (Table 3). All the studied parameters were compared with standard values given by W.H.O. and they showed against standard one because of contaminants.

Biological analysis

Biological characterization of water samples is shown in Table 4. Plate count of water samples was between $24X10^{-6}$ to 296×10^{-6}. Membrane Filtration method was performed as described by Greenberg *et al*., 1992.[9] MPN number ranges from 175 to 1600 (Table 4). After analysis

of Biological parameters Isolation of micro flora was done. Isolated bacterial isolates were grown on different selective media like Pseudomonas agar for *Pseudomonas* and EMB Agar for *E.coli*. From morphological, Gram staining, cultural characterization and biochemical characterization we identified isolates T1, T7 and T14 as *E.coli* and T2,T5 as *Pseudomonas*, T3,T6 and T11 as *Salmonella*, T4,T10 and T12 as *Bacillus*(Table 5). Morphological Characterization of Fungal isolates was done as described by Aneja, 2006.[7] We have identified these fungal isolates F1,F3,F6 as *Penicillium,* F2,F5,F8 as *Aspergillus* and F4, F7, F9 as *Fusarium*. Total and fecal coliform bacteria are sensitive and commonly used indicators of bacterial pathogen contamination of natural water were isolated. Their presence implies the potential presence of microorganisms that are pathogenic to humans. Fecal coliform bacteria have a strong correlation with fecal contamination of water from warm-blooded animals. 1 fecal coliform per 100 mL of water was detected, and then water is considered unsafe to ingest.[9,10] We found one or more coliform bacteria per 100 mL water sample. This indicates that this water is not safe for human consumption. From these biological studies bacterial isolate of *Salmonella, Pseudomonas, Bacillus* and *E. coli* were isolated. These isolates were identified with the help of identification, cultural characterization and biochemical reactions. According to water quality index and coliform count the values were higher than required.

Table 2: Physical Properties of Water Samples from Ghaggar River

Physical parameters	Water Sample Drawn On 03-02-2010					Water Sample Drawn On 18-02-2010					Water Sample Drawn On 05-03-2010					Water Sample Drawn On 21-03-2010				
	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5
Temperature (^{O}C)	18	18	18	18	18	20	20	20	20	20	26	26	26	26	26	32	32	32	32	32
Conductivity (dS/m)	0.67	O.69	0.68	0.68	0.67	0.65	0.64	0.64	0.64	0.63	0.14	0.77	0.76	0.76	0.76	0.48	0.57	0.55	0.55	0.55
Turbidity (NTU)	26	49	48	47	44	19	46	45	45	46	14	36	35	35	34	9	28	28	26	24

Table 3: Chemical Properties of water samples from Ghaggar River

Chemical Parameters	Water Sample Drawn On 03-02-2010					Water Sample Drawn On 18-02-2010					Water sample drawn on 05-03-2010					Water Sample Drawn On 21-03-2010				
	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5
pH	7.3	7.9	7.6	7.6	7.4	7.4	8.1	7.9	7.7	7.6	7.3	8.2	7.9	7.8	7.6	7.0	7.9	7.8	7.8	7.6
Salinity (mg/l)	0.4	0.5	0.4	0.4	0.4	0.2	0.4	0.4	0.4	0.4	0.1	0.5	0.5	0.5	0.4	0.2	0.4	0.5	0.4	0.4
TS (mg/l)	246.6	630	624	520	492	174	642	626	532	486	249.0	612	532	521.0	434	104	582	534	512	484
TDS (mg/l)	180.3	520	512	430	408	110	522	412	432	407	189.8	504	430	431.7	355	70.8	410	430	420	412
TSS (mg/l)	66.3	110	112	90	84	64.0	120	114	98	89	59.2	108	102	89.3	79	66.4	119	104	92	72
Alkalinity (mg/l)	106	200	196	198	195	86	196	192	204	192	76.4	149.2	136.4	124	105.2	64.2	132.4	126.4	104.4	102.4
Total Hardness (mg/l)	466.4	860.6	820.7	799.8	750.6	324.8	874.2	869.6	812	804.4	396.6	924.4	917.4	916.2	854.4	486.4	1000	986	823	786
Calcium (mg/l)	126.2	220	212.6	218.2	217	62.2	202.1	201	200.8	200.7	98.4	196	190.4	186.4	172	82.4	166.4	162.3	149	132.2
Chloride (mg/l)	76	142	142.5	139	134.2	77	152	146.4	139.4	140.6	72.4	105	82	74	62.9	66.4	94.4	86.2	62.4	46.4
Inorganic Constituent																				
Magnesium (mg/l)	3.2	7.2	7.1	6.9	6.6	2.9	6.9	7.2	7.0	6.8	3.2	9.4	8.6	8.4	7.8	1.8	8.2	7.4	7.2	7.1
Sulphite (mg/l)	0.6	2.1	2.0	1.9	2.0	0.2	1.3	1.1	1.4	1.0	1.6	2.4	2.2	1.9	2.1	0.2	2.9	1.4	1.9	1.9
Organic constituents																				
D.O(mg/l)	2.4	9.6	9.2	8.4	8.0	1.6	9.2	8.8	8.0	7.8	1.6	8.9	8.7	8.4	7.7	1.2	7.4	7.4	7.2	6.6
BOD(mg/l)	4.08	17	15.08	14.60	9.0	0.84	18.4	17.6	17.6	16.2	2.4	19.4	18.0	16.2	14.5	2.8	20.2	19.6	18.4	17.2
COD (mg/l)	12	40	28.6	19.4	12.4	11.8	36	39.4	32.6	20.4	14	39.4	35	29.6	14.0	11	36.4	34	28.4	26

Table 4: Biological Properties of water samples from Ghaggar River

Biological Parameters	Water Sample Drawn On 03-02-2010					Water sample drawn on 18-02-2010					Water Sample Drawn On 05-03-2010					Water Sample Drawn On 21-03-2010				
Plate Count (Bacteria)	$24X10^{-6}$	$64X10^{-6}$	$56X10^{-6}$	$46X10^{-6}$	$31X10^{-6}$	32×10^{-6}	86×10^{-6}	79×10^{-6}	67×10^{-6}	46×10^{-6}	46×10^{-6}	28×10^{-6}	264×10^{-6}	166×10^{-6}	124×10^{-6}	59×10^{-6}	296×10^{-6}	256×10^{-6}	194×10^{-6}	120×10^{-6}
MPN number (MPN Index/100ml)	130	1600	910	540	175	345	>1600	910	540	175	345	>1600	1600	910	540	540	>1600	>1600	1600	910
Membrane Filtration (No.of Coliforms/100ml)	54	78	79	64	52	68	94	86	52	50	62	80	82	70	66	44	98	94	82	76

Table 5: Biochemical characterization of bacterial isolates

Name of test	T1,T7,T14	T2,T5,T9	T3,T6,T11	T4,T10,T12
Starch hydrolysis	-	-	-	+
Indole production	+	-	-	-
MR reaction	+	-	+	-
VP reaction	-	-	-	-
Citrate	-	+	+	-
Urease	-	-	-	-
Catalase	+	+	+	-
Oxidase	-	+	-	+
Triple Sugar Iron Agar	-	-	+	-

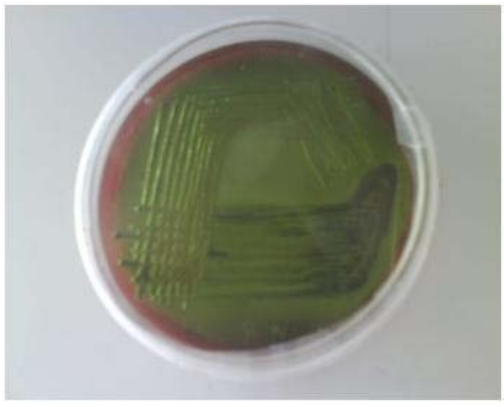

Figure 1: Growth of *E. coli* on Macconkey Agar

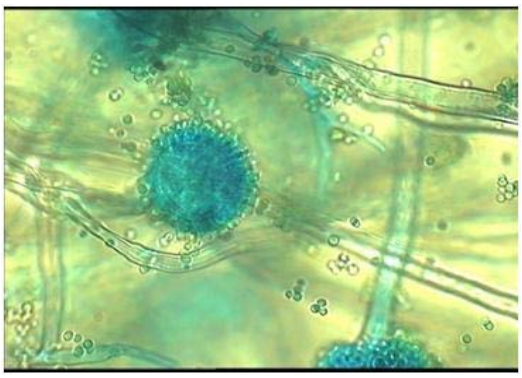

Figure 2: Microscopic view of *Aspergillus.*

CONCLUSION

These observations clearly reflect that water of Ghaggar was highly polluted. So this water of Ghaggar River is not suitable for drinking and other purposes. The main cause of this pollution was human activities and discharge from the stone crusher near the river bank. River water at most of the sites was highly influenced by the point sources pollutants at the joining points. In the study area, point sources generally carry waste waters of industrial and municipal, human wastes and agricultural runoff. Some anthropogenic activities like river bed mining, disposal of treated and untreated waste effluents from industries along with agricultural wastes and human wastes may result in deterioration of water quality of Ghaggar River System.

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