

Assessment of Microbial Biodiversity of River Ganga at Haridwar and Rishikesh



Microbiology

KEYWORDS : Biodiversity, E.coli, MPN, SPC

Nidhi Singh Chauhan

Department of Microbiology, Himalayan University, Naharlagun, Itanagar, Arunachal Pradesh

Manjul Dhiman

Department of Botany, KLDVA PG College, Roorkee

ABSTRACT

Haridwar and Rishikesh are the famous pilgrims on river Ganga. The river Ganga is regarded as one of the most holy and sacred rivers of the world from time immemorial. The evaluation of river water quality in terms of microbial analysis is a useful because most of the waterborne diseases are caused by enteric pathogens such as bacteria, viruses and parasites that are transmitted by the faecal oral route. Water quality assessment conducted at Ganga River for microbial analysis in the year 2012 and 2013. For this study water samples were collected from the Har Ki Pauri at Haridwar and Pramanand Ashram Ghat at Rishikesh. All samples were positive for E. coli, which indicates fecal pollution of water. The MPN count ranges from 300 to 450 MPN/100 ml for the water samples at Haridwar and 170 to 230 MPN/100 ml water samples at Rishikesh. The SPC count ranges from 320 to 450 SPC/ml x1000 for the water samples at Haridwar and 150 to 240 SPC/ml x1000 water samples at Rishikesh. The fecal coliform counts also exceeding the standard limit for water. The Isolated organisms were identified to be Staphylococcus aureus, Salmonella species, Escherchia coli, Pseudomonas aeruginosa, Enterobacter aerogenes and Shigella species.

INTRODUCTION

The Himalayan rivers have an important place in Indian culture and tradition. They are the lifeline of majority of population in cities, towns and villages and are considered sacred. Haridwar is a city in Northern India on the bank of the Ganga River. It is a Hindu pilgrimage center. Haridwar lies along the Ganga River at the boundary between the Indo-gangetic plain and the Himalayan foothills. The water supply of the Ganga system is partly dependent on the rains brought by the monsoon winds from July to October as well as on the flow from melting Himalayan glaciers in the hot season from April to June. Har ki pauri in Haridwar is the area where thousands of pilgrims converge and the festivities commence. Bathing activities continue for most part of the year but peak in summer. Near the Harki- Pauri faecal matter, decaying leaves, flowers, wooden parts, waste cloths, food material, ashes, and charcoals can be observed in the Ganga at this point which certainly affects the microbiological parameters of Ganga water.

Rishikesh Located in the foothills of the Himalayas in northern India, it is known as The Gateway to the Garhwal Himalayas. It is located approximately 25 km north of the city Haridwar. The Sampling point in Rishikesh was Parmanand Ghat.

A number of investigations have been carried out on the physicochemical and biological characters of the Ganga. Lakshminarayana (1965) published a series of papers reporting the results of studies carried out at Varanasi during the period between March, 1957 and March, 1958. It was observed by him that the values of the most of the parameters decreased during rainy season while no marked variation was observed during winters and summers. Bhargava (1982) in a survey of total length of the river Ganga found that quality index was far above the prescribed limit at Kanpur. He further found that the Ganga water was having unusually fast regenerating capacity by bringing down Biological Oxygen Demand owing to the presence of large amount of well adapted micro-organisms. According to the research, Ganga is rich in polymers excreted by various species of bacteria. These polymers being excellent coagulants remove turbidity by coagulation, setting the suspended particles at the sewage discharge point.

Nautiyal, P. (1990) explained the ecology of the Ganga river system in the upland of Garhwal Himalaya environment. Joshi et al. (1993) evaluated the physio-chemical characteristics river Bhagirathi in the Uplands of Himalaya. Khanna et al. (1993) studied physio-chemical and biological parameters of river Ganga

at Chandi Ghat, Haridwar. Dharendra Mohan Joshi et al. (2009) commented on the irrigation water quality of river Ganga in Haridwar district that Ganga river water in Haridwar is suitable for irrigation purpose except in rainy season. Kumar et al. (2010) concluded that the quality of water samples subjected to study was acceptable from physico-chemical parameters, while E. coli, an indicator of fecal pollution was found in all samples. The river Ganga at Brahma Kund in Haridwar was most polluted despite being a quite popular sacred place in Haridwar.

Several investigations have been carried out on the phytoplankton diversity and their relation with abiotic factors on Ganga River and its tributaries (Nautiyal, 1986, 1990; Joshi et al., 1996a). This study will be undertaken to investigate the water quality of river Ganga in Haridwar and Rishikesh during the periods of monsoon, summer and winter seasons.

RESULTS AND DISCUSSIONS

Determination of MPN and SPC at Haridwar (Har ki Pauri)

At sampling station Harki Pauri it was observed by MPN method in the year 2012-13 that MPN was highest in the month of June (summer) i.e. 440 MPN/100 ml during study year 2012 and 450 MPN /100 ml during study year 2013. The lowest value were observed in the month of October (winter) i.e. 300 MPN/100 ml during study year 2012 and 300 MPN/100 ml during study year 2013. From the SPC method it was found that during 2012 SPC of the water sample was highest in the month of June (summer) i.e. 450 SPC/ml x1000 during study year 2012 and 420 SPC/ml x1000 during study year 2013 and lowest were observed in the month October (winter) i.e. 320 SPC/ml x1000 during study year 2012 and 320 SPC/ml x1000 during study year 2013. All the other related results are represented in the Table 1 and comparative analysis of MPN and SPC is represented in the Figure 1a and 1b respectively.

Table: 1 Seasonal variation in MPN and SPC of microorganism of the sampling Station Har ki Pauri on the River Ganges in the year 2012 and 2013

Season	MPN/100ml (2012)	MPN/100ml (2013)	SPC/mlx 1000 (2012)	SPC/mlx 1000 (2013)
Summer	440	450	450	420
Post-monsoon	390	399	400	400
Winter	300	300	320	320

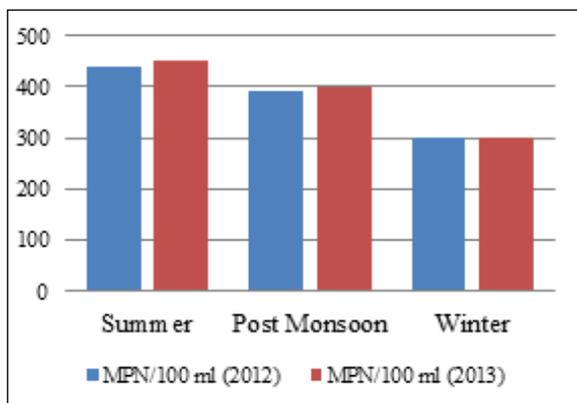


Figure 1a: Comparative MPN of the water sample at sampling station Har ki Pauri on the river Ganges in different seasons during the study period 2012-13

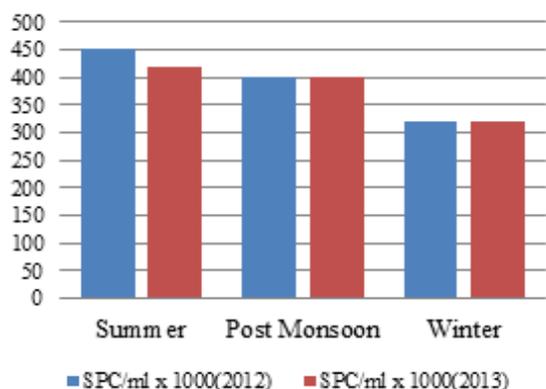


Figure 1b: Comparative SPC of the water sample at sampling station Har ki Pauri on the river Ganges in different seasons during the study period 2012-13

Determination of Total Concentration of microorganism at Haridwar

From the study of the water samples collected from the sampling station Harki Pauri during the study year 2012 the cell concentration of *E. coli* was observed between 40-180x10³/ml. The cell concentration of other microorganisms such as *Salmonella* was between 12-50x10³/ml, *Shigella* ranged between 10-36x10³/ml, *Staphylococcus aureus* ranged between 09-22x10³/ml, *Enterobacter aerogenes* ranged between 06-29x10³/ml, *Pseudomonas* ranged between 02-20x10³/ml. The cell concentration for the year 2013 of different microorganism in water sample was observed for *E. coli* ranged between 80-200x10³/ml, *Salmonella* ranged between 10 -30x10³/ml, *Shigella* ranged between 12-40x10³/ml, *Staphylococcus* ranged between 09-20x10³/ml, *Enterobacter aerogenes* ranged between 05-20x10³/ml, *Pseudomonas* ranged between 0-30x10³/ml. (Table 2 and Figure 2a and 2b)

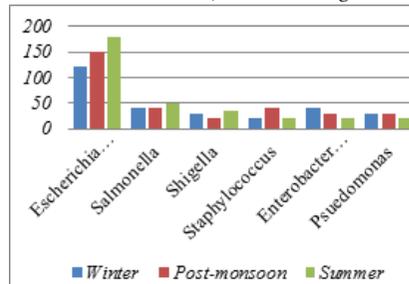


Figure 2a: Comparative cell concentration of different microorganisms in the water samples at sampling station Har ki Pauri on the River Ganges in different season during the study year 2012

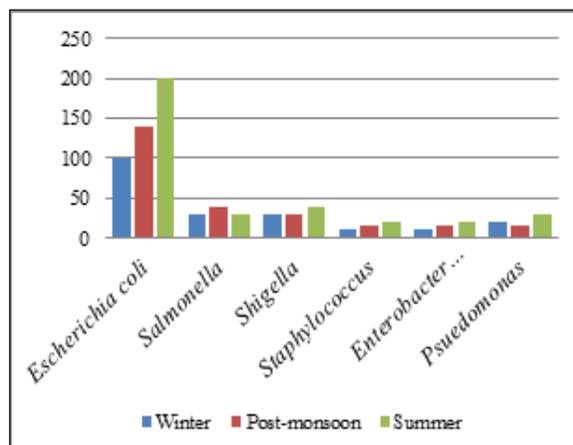


Figure 2b: Comparative cell concentration of different microorganisms in the water sample at sampling station Harki Pauri on River Ganges in different season during the study year 2013

Table 2: Seasonal variation in the cell concentration of different microorganism from the water samples from sampling station Har ki Pauri on River Ganges during the study period 2012-13

Year	2012				2013			
	Winter	Post-monsoon	Summer	Average	Winter	Post-monsoon	Summer	Average
Escherichia coli	120	150	180	150	100	140	200	147
Salmonella	40	40	50	43	30	40	30	33
Shigella	30	20	36	29	30	30	40	33
Staphylococcus	20	40	22	27	10	16	20	16
Enterobacter aerogenes	40	29	20	30	10	16	20	15
Pseudomonas	30	30	20	27	20	15	30	22

Determination of MPN and SPC at Rishikesh:

At sampling station Parmanand Ghat, it was observed by MPN method in the year 2012-13 that MPN was highest in the month of June (summer) i.e. 230 MPN/100 ml during study year 2012 and 225 MPN /100 ml during study year 2013. The lowest value were observed in the month of October (winter) i.e. 180 MPN/100 ml during study year 2012 and 170 MPN/100 ml during study year 2013. From the SPC method it was found that dur-

ing 2012 SPC of the water sample from sampling station A4 was highest in the month of June (summer) i.e. 240 SPC/ml x1000 during study year 2012 and 230 SPC/ml x1000 during study year 2013 and lowest were observed in the month October (winter) i.e. 150 SPC/ml x1000 during study year 2012 and 150 SPC/ml x1000 during study year 2013. All the other related results are represented in the Table 3 and comparative analysis of MPN and SPC is represented in the Figure 3a and 3b respectively.

Table 3: Seasonal variation in MPN and SPC of microorganism of the sampling Station Rishikesh on the river Ganges in the year 2012 and 2013

Season	MPN/100ml (2012)	MPN/100ml (2013)	SPC/mlx 1000 (2012)	SPC/mlx 1000 (2013)
Summer	230	225	240	230
Post-monsoon	190	200	200	230
Winter	180	170	150	150

Figure 3a: Comparative MPN of the water sample at sampling station Rishikesh on the river Ganges in different seasons during the study period 2012-13

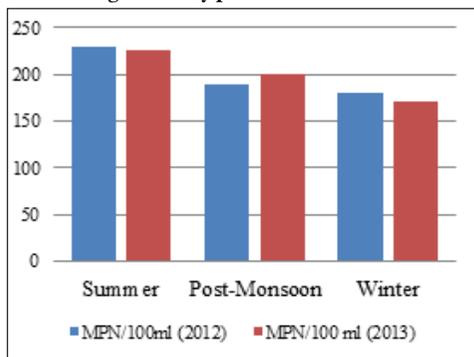


Figure 3b: Comparative SPC of the water sample at sampling station Rishikesh on the river Ganges in different seasons during the study period 2012-13

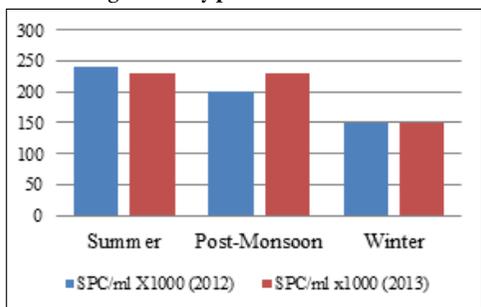


Table 4: Seasonal variation in the cell concentration of different microorganism from the water samples from sampling station Rishikesh on River Ganges during the study period 2012- 13

Year	2012				2013			
	Winter	Post-monsoon	Summer	Average	Winter	Post-monsoon	Summer	Average
Escherichia coli	50	40	80	21.66	10	17	45	17.33
Salmonella	20	15	20	15	09	15	18	14
Shigella	10	10	14	10	07	09	11	9
Staphylococcus	10	08	10	07	05	09	11	8.33
Enterobacter aerogenes	06	09	10	8.33	04	07	10	03
Pseudomonas	Nil	06	08	4.66	02	07	09	06

Figure 4b: Comparative cell concentration of different microorganisms in the water sample at sampling station Rishikesh on River Ganges in different season during the study year 2013

CONCLUSIONS

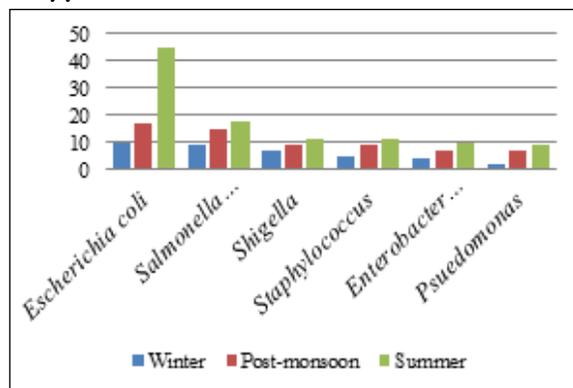
Bacteriological analysis showed six bacteria in river water samples and all samples had *E.coli*, as indicator of faecal pollution other bacteria are *Staphylococcus*, *Salmonella*, *Shigella*, *Pseudomonas*, *Enterobacteraerogenes*. During the study, the average values showed that three species i.e. *Escherichia coli*, *Enterobacteraerogenes*, *Staphylococcus* were found to be dominating in Haridwar than the Rishikesh, it may be because some Domestic sewage drains are meeting in river at Haridwar. So the appraisal of water of Ganga river with respect to bacteriological pollution is of immense significance for improving living standard and quality of life in this region. Therefore, monitoring of microbial

Determination of Total Concentration of microorganism at Rishikesh

From the analysis of the water sample at the sampling station Rishikesh G2 on river Ganges during the study year 2012, the cell concentration of the *E. coli* ranged between 12-80x103/ml. The cell concentration of the other microorganisms was as *Salmonella* ranged between 10-20x10/ml, *Shigella* ranged between 08-14x103/ml, *Staphylococcus aureus* ranged between 06-10x103/ml, *Enterobacter aerogenes* ranged between 04-10x103/ml, *Pseudomonas* ranged between 0-08x103/ml.

During the study year 2013, the cell concentration of *E. coli* ranged between 10-45x103/ml is followed by *Salmonella* ranged between 08-18x103/ml, *Shigella* ranged between 05-11x103/ml, *Staphylococcus* ranged between 04-11x103/ml, *Enterobacter aerogenes* ranged between 04-10x103/ml, *Pseudomonas* ranged between 0-09x103/ml. All the other related is represented in the Table 4 and comparative analysis of cell concentration for the year 2012 is represented in Figure 4a and for the year 2013 in Figure 4b.

Figure 4a: Comparative cell concentration of different microorganisms in the water sample at sampling station at Rishikesh on River Ganges in different season during the study year 2012



contamination on periodic basis should be an important component of the protection strategy in this area. Also, understanding of pathogenic bacterial genera in

Ganga river system is important and useful to arrive at measures that may act as indicators of water quality and pollution

REFERENCE

- [1] Bhargava, D.S., (1982). Purification power of the Ganga Unmatched, L.S.T. Bull. 34. 52. [2] Dharendra Mohan Joshi, (2009). Assessment of the Irrigation Water Quality of River Ganga in Haridwar District, RASAYAN J. Chem. 2, 285. [3] D.R Khanna, (1993). Ecology and pollution of Ganga River, Ashish Publishing House, Delhi, 1. [4] Joshi, B.D., Bisht, R.C.S. and Joshi, N. (1996a). Planktonic population in relation to certain physico-chemical features of Ganga canal at Jawalapur (Hardwar). *Him. J. Environ. Zool.* 10, 75-77. [5] Joshi, B.D., Bisht, R.C.S. Joshi N. and Singh, R. (1996b). A study of planktonic and benthic components of three selected tributaries of River Ganga between Devprayag and Rishikesh. *Him. J. Environ. Zool.* 10, 23-26. [6] Kumar et al., (2010). Physical, Chemical and Bacteriological Study of Water from Rivers of Uttarakhand. *J Hum Ecol.* 32(3), 169-173. [7] Lakshminarayana, J.S.S. (1965). Studies of the phytoplankton of the river Ganga, Varanasi, India, Part-I. Physico-chemical characteristics of River Ganga. *Hydrobiologia.* 25. 119-175. [8] Nautiyal, P. (1990). Ecology of the Ganga River System in the Uplands of Garhwal. In: Himalaya, Environment, Resources and Development, Shah, N.K., S.D. Bhatt and R.K.Pande (Eds.). Shree Almora Book Depot, Almora, pp: 69-73.