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Research Paper

ASSESSMENT OF MICROBIAL BIODIVERSITY OF RIVER GANGA AT HARIDWAR AND RISHIKESH

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Haridwar and Rishikesh are the famous pilgrims on river Ganga. The river Gang is regarded as one of the holy and sacred rivers of the world from time immemorial. The

emorial. 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 sam- ples 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 aerugionosa, Enterobacter aerogenes and Shigella species.***

Assessment, Microbial, Biodiversity , River Ganga, Haridwar and

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.

AND DISCUSSIONSULTS SER

At *rmination of MPN and SPC at Haridwar (Har ki Pauri) eteD* sampling station Harki Pauri it was observed by MPN meth- od 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 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.

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

able: 1 Seasonal variation in MPN and SPC of microorgan- T ism of the sampling Station Har ki Pauri on the River Ganges in the year 2012 and 2013

rmination of Total Concentration of microorganism ateteD

From the study of the water samples collected from the *Haridwar* sampling station Harki Pauri during the study year 2012 the cell

مقدمة

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. Hardwar is a city in Northern India on the bank of the Ganga River. It is a Hindu pilgrimage center. Hardwar lies along the Ganga River at the boundary between the Indogangetic 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 HarkiPauri 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 physiochemical 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 adopt- ed microorganisms. 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. Dhirendra Mohan Joshi et al. (2009) commented on the irrigation water quality of river Ganga in Haridwar district that Ganga river

represented in the Table 3 and comparative analysis of MPN and SPC is represented in the Figure 3a and 3b respectively.

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

SPC/mlx 1000 (2013)	SPC/mlx 1000 (2012)	MPN/10 0ml (2013)	MPN/10 0ml (2012)	Season
230	240	225	230	Summer
230	200	200	190	Post-mon soon
150	150	170	180	Winter

sheskihsiR

From the analysis of the water sample at the sampling station Rishikesh G2 on river Ganges during the study year 2012, the cell ranged between 12-80x103/ml. The cell *E. coli* concentration of the 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 ranged between 10-45x103/ml is followed by *E. coli* concentration of Salmonella ranged between 08-18x103/ml, Shigella ranged ranged between *Staphylococcus* between 05-11x103/ ml, ranged between *Enterobacter aerogenes* 04-11x103/ml, ranged between 0-09x103/ml. All the *Pseudomonas* 04-10x103/ml, 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.

able 4 : Seasonal variation in the cell concentration of differentT microorganism from the water samples from sampling hikesh on River Ganges during the study period 2012-siRstation

2013	2012	Year **13**
Su m me r Post-monsoon	Winter	Bacteria
80	40	50	Escherichia coli
20	15	20	Salmonella
14	10	10	Shigella
10	08	10	Staphylococcus
10	09	06	Enterobacter aerogenes
08	06	Nil	Pseudomonas

was observed between 40-180x103/ml. The *E. coli* concentration of was *Salmonella* cell concentration of other microorganisms such as ranged between 10-36x103/ *Shigella* between 12-50x103/ml, *r etcaEnterob* ranged between 09-22x103/ml,*Staphylocccus aureus* ml, ranged *Pseudomonas* ranged between 06-29x103/ml,*aerogenes* between 02-20x103/ml. The cell concentration for the year 2013 of *E.* different microorganism in water sample was ob- served for ranged between 80 200x103/ml, Salmonella ranged between 10 *coli* ranged between 12-40x103/ *Shigella* -303/ml, *Enterobacter* ranged between 09-20x103/ml, *Staphylococcus* ml, ranged *Pseudomonas* ranged between 05-20x103/ml, *aerogenes* between 0-30x103/ml. (Table 2 and Figure 2a and 2b)

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

Summer
180
50
36
22
20
20

At sampling station *rmination of MPN and SPC at Rishsikesh:eteD* 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 during 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

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Bacteriological analysis showed six bacteria in river water sam- ples and all samples had E.coli, as indicator of faecal pollution other bacteria are Staphylococcus, Salmonella, Shigella, Pseu- domonas, Enterobacteraerogenes. During the study, the average values showed that three species i.e. Escherichia coli, Entero- bacteraerogenes, 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 contamination on periodic basis should be an important com- ponent of the protection strategy in this area. Also, understand- ing 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

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