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Impact of mass bathing during Ardhkumbh on water quality status of river Ganga

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Abstract: *The study highlighted that mass bathing during Ardhkumbh caused the changes in the river water quality and indicated that water is not fit for either drinking or bathing purposes. The presence of faecal coliforms in water also hints at the potential presence of pathogenic microorganisms, which might cause water borne diseases. Although the water was found to be safe with respect to dissolved oxygen content, the values of BOD and COD exceeded the maximum permissible limit during bathing.*

Key words: *BOD, COD, DO, Total coliforms, Faecal coliforms.*

Introduction

For centuries a dip in the Ganges has remained the most sanctifying event for the Hindus. Various pilgrim centers, which develop by the side of Ganga, are known virtually for the sanctification of mind and soul. Both the Kumbh and Ardh Kumbh mela are regarded in the high esteem for an organized dipping in the river Ganga.

The Ardhkumbh was celebrated at Hardwar, Uttaranchal between 26th January and 15th May 2004. This unique celebration of faith, hope, joy and immortality was spread over 135 sq km and it is estimated that 60 lakh people had taken the holy dip in this area on 12 different auspicious dates. God knows that whether the mind and soul of such a large crowd will be sanctified or not but it is evident from a course of studies carried out by different researchers (Tiwari and Mishra, 1986; Srivastava *et al.,* 1996; Gupta and Deshpande, 2004 and Narain, 2004) that water resources of our country including Ganga water is highly contaminated and people can be infected with various diseases by taking bath in Ganga. Keeping in view all these facts in mind, the present study had been designed to detect the changes in number of total coliforms, faecal coliforms, dissolved oxygen, chemical oxygen demand and biological oxygen demand before and after the holy dip of Ardhkubh.

Materials and Methods

The water samples were taken from ten different ghats (Table 1). The sampling was done by immersion type of sampling method from 40 cm depth of water body and in plastic containers. The sampling was done before and during the Ardh -kumbh Snan (26 January 2004).

Total coliforms: Five test tubes containing 10 ml of double strength lactose broth and 10 test tubes containing single strength lactose broth with durhams tubes were taken. The collected water samples were inoculated in each lactose broth tubes i.e. 10 ml water sample was inoculated into each five tubes containing 10 ml double strength lactose broth, 1 ml water sample was inoculated into five tubes containing 5 ml single strength broth and 0.1 ml water sample inoculated into each 5 tubes containing 5 ml single strength lactose broth. All the test tubes were incubated at 37 ºC for 24-28 hr. After incubation, all the tubes were observed for acid and gas production. The production of acid and gas indicated the presence of coliforms and thus test was considered positive.

Faecal coliforms: EC broth was inoculated with loopful of inoculants from positive MPN tubes for coliforms form above experiments and after incubation (45 ºC for 24 hr) results were taken.

Differentiation of coliforms (IMViC Tests): The IMViC reactions ++ - - and -+- - designated *E.coli*. The methyl red reaction is the most consistent for *E. coli*. Combination + - - - also represented faecal origin contamination. If IMViC is - - ++ and + - + +, it represented *Enterobacter aerogens*. Combination - - + - and - - - - + also represented soil origin contamination. - + - + and + + - + combination represented intermediate groups. All are methyl red positive and Voges Proskauer (VP) negative. Most are citrate positive while indole production varies. Other possible combination falls in irregular groups showing different pollution sources. IMViC tests were only performed for those samples, which showed some values of MPN/100 ml of coliforms.

Biochemical oxygen demand (BOD), Chemical oxygen demand (COD) and transmittance: BOD samples were incubated at 27 ºC ($\pm$ 1ºC) in BOD incubator for 3 completed days after dilution with oxygenated water. Initial dissolved oxygen of oxygenated water was estimated and after 3 days incubation period, dissolved oxygen was also measured using Winkler method and BOD was calculated as per APHA (1998).

Chemical oxygen demand (COD) was measured by Dichromate reflux method and chemical characters of water were analyzed as per APHA (1998). Transmittance was measured with the help of spectrophotometer.

Results and Discussion

Total coliforms: Most probable number (MPN) of coliforms measures the degree of coliforms in 100 ml of water. It is generally believed that more is the most probable number of coliforms, higher is the extent of pollution in a given sample.

It is evident from the data presented in Table 2 that the MPN of coliforms ranged from 50 to 1600 per 100 ml in water samples collected before the dip. The highest MPN i.e. 1600 per 100 ml was recorded in S-2, S-9 sample followed by sample no. S-1, S-3, S-4, S-6, S-7, S-8, S-10 and minimum was observed in sample S-5.

Water samples collected after the dip registered marked increase in the MPN values. The total coliform levels in different ghats ranged from 350 to 1600 MPN during dipping. Barring one or two ghats, the coliform count exceeded 500 MPN which in the safe limit for bathing. These ghats included Har ki pauri and VIP ghat which recorded highest i.e. greater than 1600 MPN coliform level during dipping.

Results of present studies are in close conformity to the findings of Annapoorani and Lakshmanpurmalsamy (1989); Ramanibai (1997), and Bhadra *et al.* (2003) who have performed the total coliform tests on different water bodies and noticed heavy bacterial contamination.

Faecal coliforms: The faecal coliforms are used as an indicator of human enteric pathogen for many years. It is well established that *E. coli* is not limited to humans but also exists in the intestine of many warm-blooded animals (Orskov and Orskov, 1981). Therefore, its presence in water in not restricted to human source of pollution. Consequently faecal pollution can degrade water quality and restrict its use for drinking and recreational activities. Similar picture was observed in the present study where the faecal coliform population was found to increase after the dip. The faecal coliform ranged from 33 to 1600 before the dip and during the dip respectively.

Table – 1: List of different ghats from where water samples were collected

S. No.	Name	Sample No.
1	Har ki pauri	S-1
2	VIP ghat	S-2
3	Brahm kund	S-3
4	Kangra ghat	S-4
5	Asthipravah ghat	S-5
6	Ghantaghar ghat	S-6
7	Subhash ghat	S-7
8	Gaughat	S-8
9	Vishnu ghat	S-9
10	Kusha ghat	S-10

The highest value was recorded at S-2 ghat followed by S-4, S-5, S-6, S-7, S-8, S-9 and minimum was recorded at S-10. Human activities and sewage overflows may be the main reason behind higher faecal contamination in river Ganga. Mohapatra *et al.,* (1992) and Bhadra *et al.* (2003) have also examined the presence of faecal coliforms as indicators of faecal pollution in various water bodies. The present study draws support from the findings of these workers.

Differentiation of coliforms (IMViC Tests): A glance at the data presented in the Table 3 regarding coliform differentiation in various water samples collected before and after the dip revealed that the number of contaminants was in the order of soil origin (7) > *E. coli* (6) > intermediate (5) in samples collected before the dip and the sequence *E. coli* (13) > Soil (4) > Intermediate (2) was reported in samples collected after the dip.

The samples S 1, S-2, S-8 showed the presence of faecal coliforms which might be due to faecal discharge of diseased person or worm blooded animal which might have entered the Ganga water during the dip or it might be due to sewage contamination. Similar studies have also been carried out by Erwine and Pettibone (1996) and Moustafa *et al.* (1997).

Dissolved oxygen (DO): Dissolved oxygen is an important parameter to determine the water quality for various purposes. Dissolved oxygen concentration in a water body indicates its ability to support aquatic life and reflects physical and biological process prevailing in water. Good water should have solubility of oxygen i.e., 7.6 and 7 mg/l at 30 and 35ºC respectively (Chaturvedi *et al.,* 2003). Oxygen saturated water have pleasant taste.

In the present study, the DO of water samples collected from various ghats was between 9.7 to 15.2 mg/l before dip and 9.7 to 14 mg/l after the dip. Thus, the water can be regarded safe with respect to dissolved oxygen content.

Table – 2: Effect of mass bathing on total coliforms, faecal coliforms in water samples collected from different ghats.

Sample No.	Total coliforms (MPN)		Faecal coliforms (MPN)	
	Before dip	During dip	Before dip	During dip
S-1	350	> 1600	>33	1600
S-2	1600	> 1600	26	>1600
S-3	300	> 1600	26	170
S-4	500	> 1600	21	>34
S-5	50	1600	4	50
S-6	80	350	9	34
S-7	500	>1600	>17	>17
S-8	300	>1600	2	7
S-9	1600	>1600	4	9
S-10	350	>1600	2	4

Table – 3: Differentiation of coliforms in water samples.

Sample No.	IMViC results	
	Before dip IMViC	During dip IMViC
S-1	- + - -	- + - -
		- + - -
		- + - -
S-2	- + - +	- + - +
		- + - -
		- + - -
S-3	- - - +	- - - +
	- - + -	- - - +
S-4	- + - +	- - - +
	- - - +	- - - +
S-5	- + - -	- + - -
	- + - +	
S-6	- + - -	- + - -
	- + - +	
S-7	- - - +	- + - +
	- + - +	
S-8	- + - +	- + - -
	- + - -	- + - -
S-9	- - - +	- + - -
	- - - +	- + - -
S-10	- - - +	- + - -
	- - - +	- + - -

Pandey and Sundaram (2002), Bhadra *et al.* (2003) and Chaturvedi *et al.* (2003) have also studied water quality parameters including dissolved oxygen and results were similar to the findings of present investigation.

Biochemical oxygen demand (BOD): Biological oxygen demand gives an idea of quantity of biodegradable organic substances present in water, which is subjected to aerobic decomposition of microorganism. Thus, it provides a direct measurement of state of pollution. The present study clearly indicated that the BOD was comparatively higher after the dip as compared to before the dip (Table 4). The BOD values ranged from 0.1 to 4 mg/l before the dip and 0.4 to 4.7 mg/l after the dip. Hynes (1960) has stated that water having BOD values of 3 mg/l or more is of doubtful quality and that with more than 5 mg/l is bad. Accordingly, the water sample collected from Har Ki Pauri (S-1) was of unsatisfactory quality after the dip and water collected from Brahmkund (S-3) witnessed higher BOD values and thus is not safe. Rest of the water samples collected from different ghats recorded BOD values less than 3 mg/l. Dhanapakiam *et al*. (1999) Singh *et al*. (1999), Sharma *et al.* (2000), Pandey and Sundaram (2002) and Sudhakar and Mamatha (2004) have also stated contamination of water resources by biological, organic and inorganic pollutants. The present study draws support from the findings of these workers.

Chemical oxygen demand (COD): Chemical oxygen demand is the measure of oxygen required for chemical oxidation. Its values are generally higher than BOD values when organic matter contains a large amount of biologically resistant substances. In the present investigation, COD was invariably higher than BOD at all the places of water collection. COD values ranged from 1.6 to 6.4 mg/l before the dip and 9.6 to 64.0 mg/l after the dip during the course of investigation. The maximum COD value was recorded from Subhash Ghat (S-7) followed by Vishnu Ghat (S-9) lowest values (9.6) were noticed in VIP Ghat (Table 4).

Results of present investigation draw support from the finding of Singh *et al.* (1999a), Sharma *et al.* (2000) and Chaturvedi *et al.* (2003). The higher COD might be due to the presence of huge amount of accumulated organic matter and its incomplete oxidation. These high values indicated the Ganga water was rich with respect to non-biodegradable organic matter as the majority of water samples collected after the dip crossed the maximum permissible level of COD i.e. 10 mg/l for drinking water.

Transmittance: Transparency of water is directly related with the penetration of light. The lower penetration or higher turbidity values shows higher pollution load. In the present study, transmittance of water samples collected from different ghats before and after dip was measured at wavelength 570 nm and compared with control i.e. distilled water, which was of 100 transmittance.

Table – 4: Effect of mass bathing on DO, BOD, COD and transmittance.

Sample No.	DO (mg/l)		BOD (mg/l)		COD (mg/l)		Transmittance	
	Before dip	During dip	Before dip	During dip	Before dip	During dip	Before dip	During dip
S-1	11.6	14.0	1.6	3.6	4.8	19.2	100.0	98.1
S-2	11.6	10.8	0.4	2.6	3.2	9.6	99.7	99.0
S-3	15.2	9.70	4.0	1.8	1.6	14.4	99.8	96.8
S-4	11.3	10.4	2.3	2.4	1.6	14.4	99.2	98.2
S-5	11.0	10.6	1.2	3.0	3.2	19.2	100.0	99.0
S-6	10.4	10.0	0.4	1.8	1.6	28.8	100.0.	98.6
S-7	10.0	9.8	0.4	1.4	1.6	64.0	100.0.	99.1
S-8	9.7	10.0	0.1	0.6	1.6	19.2	100.0.	96.1
S-9	10.1	9.6	0.5	0.4	3.2	30.4	100.0.	94.5
S-10	10.0	9.6	1.0	0.4	6.4	28.8	99.8	95.8

Data presented in table 4 clearly points out that mass bathing affected the transparency of water. Most of the water samples collected before the dip showed 100% transmittance but after the dip transmittance less than 100% was recorded in majority of water samples, which ultimately signifies the accumulation of soluble and suspended matter in the water during the dipping.

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