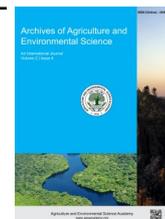This content is available online at AESA

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A CASE STUDY

CrossMark

Water quality of River Ganga with reference to physico-chemical and microbiological characteristics during Kanwar Mela 2017, at Haridwar, India: A case study

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ABSTRACT

The present investigation was conducted to study the water quality of river Ganga during Kanwar Mela 2017 with reference to physico-chemical and microbiological characteristics at Haridwar city. Five sampling sites *viz.*, Har ki Pauri (HKP), Vishnu Ghat (VG), Daksh Mandir (DM), Pul Jatwara (PJ) and Bhimgoda Barrage (BGB as control) were selected for collection of water samples. The reseult revealed that among the different sampling sites, the maximum values of EC (0.164 dS m^{-1}), TS (545 mg L^{-1}), TDS (320 mg L^{-1}), TSS (225 mg L^{-1}), pH (8.76), DO (10.04 mg L^{-1}), BOD (4.76 mg L^{-1}), COD (6.89 mg L^{-1}), Cl$^-$ (124.50 mg L^{-1}), Hardness (232.54 mg L^{-1}), Alkalinity (158.36 mg L^{-1}), NO$_3^{2-}$ (76.88 mg L^{-1}), SO$_4^{2-}$ (228.34 mg L^{-1}), SPC (6.8×10^6 SPC ml $^{-1}$), MPN (4.6×10^8 MPN 100 ml $^{-1}$), Cd (BDL), Cu (0.171 mg L^{-1}), Cr (1.503 mg L^{-1}), Fe (3.642 mg L^{-1}), Ni (BDL) and Zn (2.456 mg L^{-1}) of Ganga River water were recorded higer at Har ki Pauri (HKP) in comparison to Vishnu Ghat (VG), Daksh Mandir (DM), Pul Jatwara (PJ) and Bhimgoda Barrage (BGB) sampling sites. Therefore, it was concluded from the present investigation that the mass bathing and relegious activities greatly influenced the water quality of River Ganga and significantly contributed to the water pollution of River Ganga during the Kanwar Mela 2017.

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INTRODUCTION

India has a unique place due to its religious, political, historical, geographical, environmental, socio-cultural, and as an emerging economic power not only in South Asian Countries, but also in the world (Yasir and Srivastava, 2016). Almost all the communities as Hindus, Muslims, Sikh and Christians are lived together and celebrated their auspicious events of happiness and sorrows together. Festivals has important place in human life as they bring lots of delight, enjoy and also social harmony. India is a land of festivals, parvas, melas and mahotsavas. Among festivals Deepawali, Holi, Nav Durga, Ganga Dashehara, Id-Ul-Fitre and Christmas is being celebrated by the native communities of India (Kamboj, 2012; Kamboj *et al.*, 2017).
Haridwar is a holy city and municipal board in the Haridwar

District of Uttarakhand State, India. In Hindi, Haridwar ('Hari' meaning god and 'dwar' meaning gate) stands for Dwar of Hari or Gateway to God. Haridwar is regarded as one of the seven holiest places to Hindus (Charles, 1903; Rupinder and Reeta, 2004). Haridwar is one of the first towns where Ganga emerges from the Gangotri glacier in Himalayan Mountains to touch the plains. The water in the river Ganga is mostly clear and generally cold, except in the rainy season, during which soil from the upper regions flows down into it. Being a place of intense religious significance, Haridwar also hosts several religious festivals, Melas (fairs) throughout the year; popular among them are the Maha Kumbh, Ardha Kumbh, Kavar Mela, Somvati Amavasya Mela, Ganga Dashara, and Gughal Mela, in which around millions of people take part. The spot where the nectar fell is considered to be the Brahma Kund at Har ki Pauri

(literally, "footsteps of the Lord," and symbolically the footprints of the Amrita), the most sacred ghat of Haridwar; thousands of devotees and pilgrims flock here during festivals or *snan* (Bath) from all over India and abroad to take a holy dip. Har ki Pauri, Vishnu Ghat, Chandi Devi Temple, Mansa Devi Temple, Maya Devi Temple, Daksha Mahadev Temple, Neel Dhara Pakshi Vihar, Sati Kund, Bhimgoda Tank, Jairam Ashram, Sapt Rishi Ashram and Sapt Sarovar, Parad Shivling, Ramanand Ashram, Prem Nagar Ashram, Ram Mandir, Doodhadhari Barfani Temple, Sureshvari Devi Temple, Paavan Dham, Bharat Mata Mandir, Anandamayi Ma Ashram, Piran Kaliyar are important religious places of Haridwar (Rupinder and Reeta, 2004). Celebration of festivals has great importance in Haridwar. As people of different religions and communities of national as well as foreign gathered here and take parts in celebration of festivals and in Haridwar. The festival Kanwar Mela is organized every year in the month of July in Haridwar and it is devoted for the worship of Almighty God Shiva. The pilgrims (Devotees of God Shiva) come to Haridwar, take holy bath in Ganga River and perform religious rituals and finally they return to their place with Ganga water (Ganga Jal) and offer it to the Shivlingam in the temple of God Shiva at their destinations (Charles, 1903; Rupinder and Reeta, 2004).

Rivers have a great importance and place in Indian civilization. These are considered as live entity and having a place as mother in the life of people in India. Ganga River is considered as most of the sacred river among different rivers in the country. People take baths in to the holy river and perform their rituals (Rizwan *et al.*, 2016; Yasir and Srivastava, 2016). A number of tourist picnic spots and pilgrim centers and religious points have been established to perform various religious as well as recreational activities (Kumar and Chopra, 2012a,b,c; Kamboj, 2012; Kumar *et al.*, 2016; Kamboj *et al.*, 2017; Kumar and Thakur, 2017). During this, the quality of water of these rivers gets polluted severely. Therefore, most of the rivers in India are facing religious pollution due to the performance of heavy religious as well as recreational activities (Khullar and Khullar, 2004; Sati and Paliwal, 2008; Seth *et al.*, 2016). The quality of Ganga River water is adversely polluted on the different occasions and celebrations of various festivals like holy bath, Kanwar Mela, Kumbh Mela and Ardhakumbha Mela etc. due to bathing of huge mass of pilgrims. The physico-chemical and microbiological characteristics of the Ganga River water has crossed the permissible or desirable limits (BIS, 2012) for almost all the parameters during these celebrations. The changes in the water quality in terms of physic-chemical and microbiological characteristics of a number of sacred rivers, lakes, streams, ponds (Kunds) and other water bodies have been reported by a number of researchers and suggested the regular monitoring of these water courses (Vega *et al.*, 1998; Simeonov *et al.*, 2003; Okendro *et al.*, 2007; Jaji *et al.*, 2007; Shamrukh and Abdel-Wahab, 2011; Brankov *et al.*, 2012; Ilijević *et al.*, 2012; Kansal *et al.*, 2013; Haritash *et al.*, 2016; Ghosh and Biswas, 2017; Oladeji, 2017; Takić Ljiljana *et al.*, 2017). Therefore, regular monitoring of the water quality of these sacred water bodies is essential to maintain their ecological esthetic and recreational significance. Keeping in view the present case study was undertaken to assess the water quality of River Ganga with reference to physico-chemical and microbiological characteristics during Kanwar Mela 2017, at Haridwar, India.

MATERIALS AND METHODS

Desription of sampling sites
Haridwar city is situated under the Shivalik foot hills which is a part of Himalayan mountain chain. Haridwar is well connected by road to National Highway 58, between Delhi and Manapass. Nearest railway stations are at Haridwar, with direct links to all major cities of India. The nearest airport is Jolly Grant Airport, Dehradun, though Indira Gandhi International Airport, New Delhi. Five sampling sites *viz.*, Har ki Pauri (HKP), Vishnu Ghat (VG), Dash Mandir (DM), Pul Jatwara (PJ) and Bhimgoda Barrage (BGB as Control) were selected for collection of Ganges water samples during Kanwar Mela 2017. The average distance between all these sites is about 2.5 km. All these sites have an important place as per religious and recreational purposes in the city.

Collection of samples and their analysis
The Kanwar Mela is celebrated in the month of July every year. The devotees of God Shiva come to Haridwar and take holy bath in River Ganga and perform their religious activities. They took a holy dip in the river Ganga and worship the Goddess. The water samples of Ganga River from all five sampling sites were collected during the peak days of the Kanwar Mela. The samples were analyzed for various physico-chemical, microbiological and heavy metals *viz.*, temperature, electrical conductivity (EC), total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), chlorides (), hardness, alkalinity, nitrate (NO_3^{2-}), sulphate (SO_4^{2-}), cadmium (Cd), copper (Cu), chromium (Cr), iron (Fe), manganese (Mn), nickel (Ni), zinc (Zn), standard plate count (SPC) and most probably number (MPN) following standard methods (APHA, 2012). For heavy metals analysis, 50 ml sample of water was taken in digestion tube and add 10 ml conc. HNO_3 digest on electrically heated block for 1 h at 145° C. Then add 5 ml of $HClO_4$ and heated to 240° C for an additional hour. Cool and filter through Whatman # 42 filter paper and makeup volume 50 ml and was used for analysis of Cd, Cu, Cr, Fe, Mn, Ni and Zn following standard methods (APHA, 2012).

Statistical analysis
Data were analyzed for one way analysis of variance (ANOVA) for determining the difference between water parameters before and after colour celebration and standard deviation, was calculated with the help of MS Excel 2016, SPSS12.0 and Sigma plot, 2000.

RESULT AND DISCUSSION

Physico-chemical characteristics of Ganga River water

The physico-chemical characteristics of Ganga River water at different sampling sites viz., Har ki Pauri (HKP), Vishnu Ghat (VG), Daksh Mandir (DM), Pul Jatwara (PJ) and Bhimgoda Barrage (BGB) during Kanwar Mela-2017 at Haridwar are presented in Table 1.

Water temperature

During the present study, the temperature of the water was ranged (18.40-18.42°C) at different sampling sites *viz.*, Har ki Pauri (HKP), Vishnu Ghat (VG), Daksh Mandir (DM), Pul Jatwara (PJ) and the temperature (18.25°C) was slightly higher than the control site as Bhimgoda Barrage (BGB). Therefore, the temperature was recorded to be insignificantly ($P<0.05$) different at different sampling sites (Table 1).

Electrical conductivity

Conductivity is the ability of a substance to conduct electricity. The conductivity of water is a more-or-less linear function of the concentration of dissolved ions. Conductivity itself is not a human or aquatic health concern, but because it is easily measured, it can serve as an indicator of other water quality problems. If the conductivity of a stream suddenly increases, it indicates that there is a source of dissolved ions in the vicinity. Therefore, conductivity measurements can be used as a quick way to locate potential water quality problems. In the present study the EC of the water was ranged (0.156-0.164 dS m^{-1}) at different sampling sites *viz.*, Har ki Pauri (HKP), Vishnu Ghat (VG), Daksh Mandir (DM), Pul Jatwara (PJ) and the temperature (0.153 dS m^{-1}) was slightly higher than the control site as Bhimgoda Barrage (BGB). The EC was recorded to be insignificantly ($P<0.05$) different at different sampling sites (Table 1). Among different sampling sites, the value of EC (0.164±0.04 dS m^{-1}) was recorded higher at Har ki Pauri (HKP) and it was likely due to the performance of more religious activities and bathing of huge crowd mass at Har ki Pauri (HKP) as it has religious and spiritual significance. The results of EC was in agreement with Kamboj (2012) who reported the changes in EC of water of river Ganga during Kanwer Mela-2011 at Haridwar, India

pH

The pH is a measure of the amount of free hydrogen ions in water. Specifically, pH is the negative logarithm of the molar concentration of hydrogen ions. A pH of 7 is considered to be neutral. Acidity increases as pH values decrease, and alkalinity increases as pH values increase. Most natural waters are buffered by a carbon-dioxide-bicarbonate system, since the carbon dioxide in the atmosphere serves as a source of carbonic acid. The pH of water affects the solubility of many toxic and nutritive chemicals; therefore, the availability of these substances to aquatic organisms is affected. As acidity increases, most metals become more water soluble and more toxic. The value of pH was recorded to be insignificantly ($P<0.05$) different at different

sampling sites during the study (Table 1). The pH of Ganga River water was recorded in the alkaline range (8.32-8.76) at different sampling sites and it was likely due to the use of detergents by the pilgrims during the holy bath.

TS, TDS and TSS

All natural waters contain some dissolved solids due to the dissolution and weathering of rock and soil. Suspended solids are determined by filtering a known volume of water and weighing the residue. Some but not the entire suspended solids act as conductors and contribute to turbidity. Waters with high total suspended solids (TSS) are unpalatable and potentially unhealthy. The values of TS, TDS and TSS was recorded to be significantly ($P>0.05$) different at different sampling sites (Table 1). The values of TS (510-545 mg L^{-1}), TDS (300-320 mg L^{-1}) and TSS (210-225 mg L^{-1}) were ranged at different sampling sites. Among different sampling sites the most values of TS (545 mg L^{-1}), TDS (320 mg L^{-1}) and TSS (225 mg L^{-1}) were observed at was recorded higher at Har ki Pauri (HKP) and it was likely due to the performance of more religious activities and bathing of huge crowd mass at Har ki Pauri (HKP). Rizwan *et al.* (2016) also reported the higher values of TS, TDS in the water of Lidder Stream at Pahalgam, (J&K), India due to the excess tourism in Pahalgam, (J&K).

DO, BOD and COD

Dissolved oxygen (DO) is the most important pollution assessment parameter of the receiving water bodies. Stabilization of organic matter, when discharged untreated or partially treated in receiving waters, leads to depletion of their DO. Nutrients (nitrogen and phosphorus) addition due to discharge of untreated or treated sewage may lead to algal growth in streams as a result depletion of DO in waters. Thus, it is observed that all the polluting constituents of sewage have their direct or indirect effect on DO of receiving waters. The impact of an effluent or wastewater discharge on the receiving water is predicted by its oxygen demand. This is because the removal of oxygen from the natural water reduces its ability to sustain aquatic life.

Biochemical oxygen demand (BOD) is a measure of the amount of oxygen that bacteria will consume while decomposing organic matter under aerobic conditions. The main focus of wastewater treatment plants is to reduce the BOD in the effluent discharged to natural waters. Wastewater treatment plants are designed to function as bacteria farms, where bacteria are fed oxygen and organic waste. The excess bacteria grown in the system are removed as sludge. If effluent with high BOD levels is discharged into a stream or river, it will accelerate bacterial growth in the river and consume the oxygen levels in the river. The oxygen may diminish to levels that are lethal for most fishes and many aquatic insects. Chemical oxygen demand (COD) is a vital test for assessing the quality of effluents and wastewaters prior to discharge. The COD test predicts the oxygen requirement of the effluent and is used for monitoring and control of discharges, and for assessing treatment plant performance. Thus, COD is a measure of the total quantity of oxygen required

to oxidize all organic material into carbon dioxide and water. During the present investigation the most values of BOD (4.76 mg L^{-1}) and COD (6.89 mg L^{-1}) were recorded at Har ki Pauri (HKP) and it was likely due to the performance of more religious activities and bathing of huge crowd mass at Har ki Pauri (HKP). While the value of DO (8.85 mg L^{-1}) was lower at Har ki Pauri (HKP) among different sampling sites (Table 1). The values of BOD (3.25-4.76 mg L^{-1}) and COD (6.52-6.89 mg L^{-1}) were ranged at different sampling sites *viz.*, Har ki Pauri (HKP), Vishnu Ghat (VG), Daksh Mandir (DM), Pul Jatwara (PJ). The value of DO was decreased while the values of BOD and COD were increased at different sampling sites in comparison to the control site as Bhimgoda Barrage (BGB). The values of DO, BOD and COD were observed to be insignificantly (*P<0.05*) different at different sampling sites (Table 1). Kamboj (2012) reported the variation in BOD, COD and DO at different sampling sites during Kanwar Mela, 2011 at Haridwar.

Chloride, hardness and alkalinity

Alkalinity is the capacity to neutralize acids, and the alkalinity of natural water is resulting mainly from the salts of weak acids. The carbonates, bicarbonates and hydroxide are the dominant source of natural alkalinity. Reactions of carbon dioxide with calcium or magnesium carbonate create considerable amounts of bicarbonates. Organic acids such as humic acid also form salts that increase alkalinity. Alkaline waters are unpalatable and can cause gastrointestinal discomfort. Nutrients such as phosphorous and nitrogen are essential for the growth of algae and other plants. Aquatic life is dependent upon these photosynthe-

sizers, which usually occur in low levels in surface water. Excessive concentrations of nutrients, however, can over stimulate aquatic plant and algae growth.

In the present study, the values of chloride (118.36-124.50 mg L^{-1}), hardness (221.00-232.54 mg L^{-1}) and alkalinity (146.37-158.36 mg L^{-1}) was ranged at different sampling sites as Har ki Pauri (HKP), Vishnu Ghat (VG), Daksh Mandir (DM), Pul Jatwara (PJ) and these were insignificantly (*P<0.05*) different to the control (Table 1). The most values of chloride (124.50 mg L^{-1}), hardness (232.54 mg L^{-1}) and alkalinity (158.36 mg L^{-1}) were observed at Har Ki Pauri (HKP). Kumar and Chopra (2012c) reported the almost similar pattern of water characteristics of abandoned Old Ganga Canal at Haridwar (Uttarakhand) India.

NO_3^{2-} and SO_4^{2-}

In the present study, the values of NO_3^{2-} (73.00-76.88 mg L^{-1}) and SO_4^{2-} (219.40-228.34 mg L^{-1}) was ranged at different sampling sites as Har ki Pauri (HKP), Vishnu Ghat (VG), Daksh Mandir (DM), Pul Jatwara (PJ) and these were found to be insignificantly (*P<0.05*) different to the control (Table 1). The most values of NO_3^{2-} (76.88 mg L^{-1}) and SO_4^{2-} (228.34 mg L^{-1}) were observed at Har ki Pauri (HKP).

Heavy metals characteristics of Ganga River water

The heavy metals are at very low concentrations in the natural environment, and they are typically introduced to surface waters as waste from human activities. Some of the metals of concern for human and aquatic health are cadmium, lead, copper, mercury, selenium, and chromium etc. The values of Cu

Table 1. Water quality characteristics of river Ganga at different sampling sites during Kanwar Mela-2017 at Haridwar.

Parameters	BGB (Control)	Sampling sites				F-calculated	CD
		HKP	VG	DM	PJ		
Temperature (°C)	18.25 ± 1.23	18.42±1.65	18.41±2.89	18.41±2.56	18.40±1.58	2.10^{NS}	0.05
EC (dS m^{-1})	0.153 ± 0.06	0.164±0.04	0.160±0.08	0.158±0.07	0.156±0.09	0.03^{NS}	0.08
TS (mg L^{-1})	410 ± 5.42	545±2.56	530±4.68	515±2.58	510±3.66	3.22*	2.32
TDS (mg L^{-1})	280 ± 3.21	320±2.77	310±2.54	305±3.65	300±2.58	2.11*	1.09
TSS (mg L^{-1})	130 ± 3.45	225±1.25	220±2.22	210±3.21	210±2.11	1.09*	0.23
pH	8.32 ± 0.22	8.76±0.55	8.64±0.68	8.62±0.14	8.56±0.45	2.19^{NS}	0.3
DO (mg L^{-1})	10.04 ± 0.56	8.85±1.24	9.24±1.25	9.75±1.03	9.86±1.20	0.05^{NS}	0.09
BOD$_5$ at 20 °C (mg L^{-1})	2.64 ± 0.12	4.76±0.12	3.54±0.40	3.32±0.36	3.25±0.56	0.21^{NS}	0.36
COD (mg L^{-1})	6.46 ± 0.42	6.89±0.88	6.75±0.96	6.64±0.94	6.52±0.87	0.06^{NS}	0.11
Cl$^-$ (mg L^{-1})	117.12 ± 0.44	124.50±0.55	122.63±0.65	119.82±0.85	118.36±0.75	1.01^{NS}	1.09
Hardness (mg L^{-1})	225.30 ± 2.98	232.54±1.64	227.10±1.74	224.45±1.85	221.00±1.26	1.06^{NS}	2.05
Alkalinity (mg L^{-1})	145.55 ± 3.46	158.36±1.20	152.37±2.56	148.50±2.14	146.37±2.52	2.77^{NS}	3.28
NO$_3^{2-}$ (mg L^{-1})	74.62 ± 1.01	76.88±0.21	75.42±0.85	73.68±1.21	73.00±1.20	0.21^{NS}	0.45
SO$_4^{2-}$ (mg L^{-1})	212.68 ± 2.98	228.34±1.23	224.98±1.01	220.36±1.14	219.40±1.22	2.14^{NS}	2.54
Cd (mg L^{-1})	BDL	BDL	BDL	BDL	BDL	-	-
Cu (mg L^{-1})	0.161 ± 0.02	0.171±0.01	0.167±0.03	0.165±0.01	0.164±0.02	0.06^{NS}	0.04
Cr (mg L^{-1})	1.500 ± 0.03	1.503±0.06	1.503±0.06	1.438±0.04	1.434±0.05	1.10^{NS}	1.06
Fe (mg L^{-1})	3.425 ± 1.09	3.642±1.20	3.547±1.14	3.536±1.07	3.501±1.12	1.01^{NS}	1.02
Mn (mg L^{-1})	0.610 ± 0.03	0.644±0.02	0.638±0.04	0.630±0.04	0.627±0.01	0.05^{NS}	0.03
Ni (mg L^{-1})	BDL	BDL	BDL	BDL	BDL	-	-
Zn (mg L^{-1})	2.348 ± 0.12	2.456±1.03	2.421±1.02	2.365±1.25	2.354±1.01	1.01*	0.02
SPC (SPC ml^{-1})	4.5×10^5 ± 6.00	6.8×10^6 ± 6.00	5.7×10^5 ± 6.00	5.5×10^5 ± 6.00	5.4×10^5 ± 6.00	4.26**	3.59
MPN (MPN100 ml^{-1})	3.2×10^8 ± 7.00	4.6×10^8 ± 7.00	3.8×10^8 ± 7.00	3.7×10^8 ± 7.00	3.5×10^8 ± 7.00	5.03**	3.05

Mean ±SD of three values; BDL- below detection limit; CD- critical difference; Significant F -**P > 0.1%, *P> 5% level; NS- not significant; BGB- Bhimgoda barrage; HKP- Har Ki Pauri; VG-Vishnu Ghat; DM- Daksh Mandir; PJ- Pul Jatwara

(0.164-0.171 mg L^{-1}), Cr (1.434-1.503 mg L^{-1}), Fe (3.501-3.642 mg L^{-1}) and Mn (0.627-0.644 mg L^{-1}) were ranged and found to be insignificantly (*P<0.05*) different at different sampling sites as Har ki Pauri (HKP), Vishnu Ghat (VG), Daksh Mandir (DM), Pul Jatwara (PJ) in comparison to control site (Bhimgoda Barrage BGB). The most values of Cu (0.171 mg L^{-1}), Cr (1.503 mg L^{-1}), Fe (3.642 mg L^{-1}) and Mn (0.644 mg L^{-1}) were noted at Har ki Pauri (HKP) among different sampling sites. The values of Cd and Ni were noted below detection limit (BDL) at all the sampling sites (Table 1). Kumar and Chopra (2012b) reported the changes in heavy metals contents of sub canal of upper Ganga Canal at Haridwar (Uttarakhand), India due to the disposal of textile effluents in the upper Ganga Canal.

Microbiological characteristics of Ganga River water

Bacterial parameters, such as fecal coliform (FC) which serve as indicators of fecal pollution are also very important when human health is the prime concern. The specific identification of pathogenic bacteria is extremely difficult; the coliform group of organisms is used as an indicator of the presence in wastewater of pathogenic organisms. Coliform bacteria are found in intestinal tract of human beings. Coliform group of bacteria include genera *Escherichia* and *Aerobacter*. The values of SPC (5.4×10^5 - 6.8×10^6 SPC ml^{-1}) and MPN (3.5×10^8 - 4.6×10^8 MPN100 ml^{-1}) were ranged at different sampling sites as Har ki Pauri (HKP), Vishnu Ghat (VG), Daksh Mandir (DM), Pul Jatwara (PJ) and these were quite higher to the values of SPC (4.5×10^5 SPC ml^{-1}) and MPN (3.2×10^8 MPN100 ml^{-1}) in comparison to control site (Bhimgoda Barrage BGB). Among different sampling sites the most values of SPC (6.8×10^6 SPC ml^{-1}) and MPN (4.6×10^8 MPN100 ml^{-1}) were observed at Har ki Pauri (HKP) and it is likely due to the mass bathing and to perform of various religious rituals at Har Ki Pauri (HKP). Kumar and Chopra (2012c) reported the higher values of SPC and MPN in the water of abandoned Old Ganga Canal at Piran Kaliyar, Haridwar due to the disposal of sewage effluent. Rizwan *et al.* (2016) also reported the changes in water quality characteristics of Lidder Stream at Pahalgam, (J&K), India due to the excess tourism in Pahalgam, (J&K).

Conclusion

It was concluded from the present study that the physico-chemical and microbiological parameter of Ganga river water were varied at different sampling sites viz., Har ki Pauri (HKP), Vishnu Ghat (VG), Daksh Mandir (DM), Pul Jatwara (PJ) and was affected with the celebration of the festival of Kanwar Mela during 2017. Among different sampling sites, the maximum values of EC (0.164 dS m^{-1}), TS (545 mg L^{-1}), TDS (320 mg L^{-1}), TSS (225 mg L^{-1}), pH (8.76), DO (10.04 mg L^{-1}), BOD (4.76 mg L^{-1}), COD (6.89 mg L^{-1}), Cl$^-$(124.50 mg L^{-1}), Hardness (232.54 mg L^{-1}), Alkalinity (158.36 mg L^{-1}), NO$_3^{2-}$(76.88 mg L^{-1}), SO$_4^{2-}$(228.34 mg L^{-1}), SPC (6.8×10^6 SPC ml^{-1}), MPN (4.6×10^8 MPN100 ml^{-1}), Cd (BDL), Cu (0.171 mg L^{-1}), Cr (1.503 mg L^{-1}), Fe (3.642 mg L^{-1}), Ni (BDL) and Zn (2.456 mg L^{-1}) of Ganga water were recorded higer at Har ki Pauri (HKP). The gathering of huge crowd mass and their active involvement in various religious and spritual activities significantly altered the physico-chemical and microbiological characteristics of the Ganga River water and therefore these alterations contributed the water pollution of Ganga River. Therefore, it is suggested from the present study, that the mass gathering and their activites must be checked and controlled through awareness among the pilgrims to prevent the holyness of the almighty Ganga River.

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