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ORIGINAL ARTICLE

Evaluation of Physiochemical, Microbial Characteristics and Identification of Pathogenic Bacteria in Ganga and Yamuna river

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ABSTRACT

The Ganga River is the largest river in northern India, with the Yamuna River serving as its primary tributary. These two rivers converge at the Prayagraj Sangam (Allahabad). This study, conducted during the pre-monsoon and monsoon seasons of 2019, aimed to evaluate the microbiological and physiochemical characteristics of six different sites (G1, G2, G3, Y1, Y2, Y3) along the Ganga and Yamuna rivers in Prayagraj, Uttar Pradesh. Various physiochemical parameters such as pH, total dissolved solids (TDS), nitrate, lead, alkalinity, total hardness (TH), electrical conductivity (EC), and chloride were assessed. Microbial parameters including total coliform count, fecal coliform count, and bacterial isolation were also analyzed. The water quality index (WQI) was calculated based on the physiochemical parameters, revealing poor to very poor water quality at all sites. Consequently, the Ganga and Yamuna rivers were deemed unsuitable for drinking and domestic purposes. The assessed microbial parameters exceeded the permissible limits for total coliform count, fecal coliform count, and indicated the presence of various pathogenic bacteria. Therefore, regular monitoring of the Ganga and Yamuna rivers is imperative to control water pollution.

Keywords: Physiochemical, TDS, Bacteriological Analysis, WQI

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INTRODUCTION

Water is a vital natural resource essential for the sustenance and development of living organisms. Rivers serve as crucial conduits for the transportation of water, facilitating the fertility of land and supporting the growth of crops, trees, and plants.

The Ganga River originates from the Gangotri Glacier in the Himalayas and spans approximately 2704 kilometers across India and Bangladesh, traversing six states including Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal before flowing into the Bay of Bengal. The Ganga River is a lifeline for the northern part of India, providing water to over 40% of the country's population, supporting irrigation, and sustaining the aquatic environment. The Yamuna River, a primary tributary of the Ganga, originates from the Yamunotri Glacier and flows through five states in northern India, covering a distance of 1376 kilometers before merging with the Ganga at the Triveni Sangam in Prayagraj. Prayagraj is the site of the Kumbh Mela, a significant festival in Hindu mythology, held every twelve years, with the Ardhkumbh occurring every six years [4].

The term "water quality" encompasses the physical, chemical, and microbiological properties of water. Water quality is influenced by the presence of undesirable levels of organic, inorganic, heavy metal, and microbial impurities dissolved in water. Microbiological parameters such as total coliform count and fecal bacteria count are used to assess water quality. Total coliform bacteria, commonly found in decaying food, vegetables, soil, surface water, and animal and human waste, are indicative of water contamination. Fecal bacteria, a subgroup of coliform bacteria, are predominantly present in the intestines and feces of warm-blooded animals, and their presence in water can lead to waterborne diseases, skin problems, and

gastrointestinal infections. MCA media is utilized for the selective growth of fecal bacteria, supporting the growth of gram-negative bacteria while inhibiting the growth of gram-positive bacteria [5].

MATERIAL AND METHODS

Figure1: Ganga and Yamuna river map

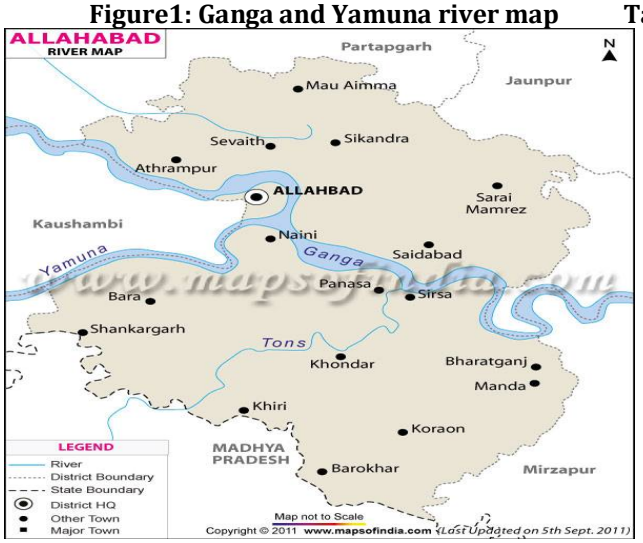

Table 1: Sites of Ganga and Yamuna river

Site of Ganga and Yamuna Ghat	coding
Shivkuti ghat	G1
Phaphamau ghat	G2
Draganj ghat	G3
Sraswati ghat	Y1
Baluaghat ghat	Y2
Arail ghat	Y3

Source: www.mapsofindia.com

Study Area: The research was conducted in the region of Prayagraj, situated in the southern part of Uttar Pradesh, with a focus on the Ganga and Yamuna river sites.

Sampling: Water samples were gathered in the year 2019 using clean and sanitized plastic bottles with a capacity of 2000 ml. The collection took place three times during both the pre-monsoon and monsoon periods from six different locations along the Ganga and Yamuna rivers. Subsequently, the samples were transported to the laboratory for analysis of their physiochemical and microbial properties.

Table 2: Method used for physiochemical & microbiological analysis of water sample, measurement unit and desirable limit of Drinking water.[6]

Physio chemical Parameter	Method	Unit	Desirable Limit
Total dissolve solid	TDS meter	ppm	<500 ppm
Total hardness	EDTA Titration	mg/L	<200 mg/L
Nitrate	spectrophotometer	mg/L	< 45 mg/L
Lead	Atomic absorption spectroscopy	mg/L	<0.01 mg/L
Electrical conductivity	Conductivity meter	µs/cm	<400 µs/cm
Alkalinity	Titration	mg/L	(20-200)mg/L
pH	pH meter	-	-
Chloride	Argentometric method	mg/L	< 250mg/L
Total coliform count	Pour plate technique	Cfu/100 ml	Non detectable
Total Fecal count	Pour plate technique	Cfu/ 100 ml	Non detectable

Microbiological parameter:

Total Coliform count: The enumeration of microbes was conducted using the pour plate technique and nutrient agar media. The incubation period for total coliform count (TCC) was 24-48 hours at 37°C. Fecal coliform count (FCC) was determined using the pour plate technique and MacConkey agar, with an incubation period of 24-48 hours at 37°C.

Bacterial identification was conducted through the analysis of nine biochemical tests, including Indole, Methyl red, Voges Proskauer, Simmon citrate, Motility test, H2S, Catalase test, Total Sugar Iron, L-arginine & Peptone test, and Nitrate reduction.

Gram strain: The Gram stain technique was utilized to differentiate between gram-positive and gram-negative bacteria based on their staining properties. Gram-positive bacteria exhibit a blue stain due to the thickness of their peptidoglycan layer, while gram-negative bacteria display a red to pink stain owing to the thinness of their peptidoglycan layer. Additionally, the morphological characteristics of the bacteria,

including their shape (spherical, helical, rod-like), size, structure, color, arrangement, and pigmentation, were examined [5].

Weighted Arithmetic Water Quality Index (WAWQI)

WAWQI first time proposed by Harton in 1965 & further, developed by Brown et al in 1972. Water quality index technique help to determine represent range of water quality in single value or (WAWQI) this tool help to set of various complex parameter convert into single value[7,8].

$$WQI = \Sigma QiWi / \Sigma Wi$$

Qi is quality rating scale for each parameter $Qi= 100 \{(Va-Vi)/ (Vs-Vi)\}$

Va= actul value of parameter which obtain after analysed sample

Vi= ideal value of each water quality parameter, except pH (7) and DO (14.6) dissolve oxygen, all the I^{th} parameter ideal value is (0)

Vs= recommended standard value of I^{th} parameter

Wi is unit weight calculated through following method.

$$Wi=K/Vs$$

K is proportionality constant and its calculated by following equation:

$$K=1/\sum(1/Vs)$$

Table 3:- Water Quality Index, BIS.[9]

WQI Value	Rating of water quality	Grading	Possible use
0-25	Excellent	A	Drinking, Domestic, irrigation and industrial
26-50	Good	B	Domestic, irrigation and industrial
51-75	Poor	C	Irrigation and industrial
76-100	Very Poor	D	Irrigation
>100	Unsuitable	E	Restricted use for irrigation

RESULT AND DISCUSSION

Physio chemical Parameter

Table 3: Mean value Physio chemical parameters of different ghat of Ganga and Yamuna in Pre monsoon season

Parameter	Y1 P	Y2 P	Y3 P	G1 P	G2 P	G3 P
TH	188	167	178	129	170	120
PH	7.9	7.8	7.9	8	7.9	8.1
Alkalinity	149	136	119	154	136	145
Chloride	58	35	77	57	45	65
TDS	567	600	555	488	529	520
NITRATE	21	32	20	19	20	20
EC	341	354	456	461	543	243
LEAD	0.02	0.6	N.D	0.23	0.16	0.03

P Pre monsoon

Table 4: Mean value Physiochemical parameters of different ghats of Ganga and Yamuna in Monsoon season

Parameter	Y1 M	Y2 M	Y3 M	G1 M	G2 M	G3 M
TH	167	168	178	179	159	160
PH	8.2	8.2	8.3	8.1	8.1	8.1
Alkalinity	179	146	133	204.85	203.01	194
Chloride	75	67	85	137	117	115
TDS	565	667	840	688	629	720
NITRATE	20	19	18	29	21	16
EC	544	387	478	643	648	511
LEAD	0.47	0.38	0.34	0.12	0.22	0.25

M Monsoon

pH: It determines acidity and alkalinity of water pH value 7 shows equilibrium stage of acidity and alkalinity. If value is less than (7-0) increasing in acidity and more than (7-14) it shows increasing in alkalinity. the maximum value of river water was analyzed 8.3 in site Y3 monsoon season & minimum value were analyzed 7.8 site in Y2 pre monsoon season. Kaur in 2014 reported ganga river pH 7.5 [2]; while on other hand Tripathi (2016) analysed pH 6.76 to 8.03 [1].

Total Dissolve Solid: Total dissolve solid is presence of inorganic content in form of ions and cations in water such as carbonate, chloride, sulphate, nitrate, potassium, magnesium, calcium, sodium. The

maximum value was estimated 840 ppm in site Y3 monsoon season & minimum value were estimated 488ppm site G1in pre monsoon season. Kaur in 2014 reported ganga river higher value of TDS 1668 ppm [1].

Total Hardness: Presence of calcium carbonate & magnesium in water determine water hardness, maximum value was recorded 188 mg/L in site Y3 monsoon season & minimum value were analyzed 120 mg/L in site G3 pre monsoon season [1].

Nitrate: maximum value was recorded 32 mg/L in site Y2 monsoon season & minimum value were recorded in site 18 mg/L in site Y3 pre monsoon season. While on other hand lower nitrate value 0.11mg/L reported by Tripathi [1].

Alkalinity: it maintain buffering capacity of water and maintain the pH level, maximum value were recorded 204 mg/L in site G1 monsoon season & minimum value were recorded 119 mg/L in site Y3 pre monsoon season. Singh *et al* reported alkalinity 218- 840 higher than permissible limit in Yamuna River [3].

Lead: lead is heavy toxic metal and is easily absorb through gastrointestinal tract and causes various ill health effect. Maximum value of lead were analyzed 0.47 mg/L monsoon season in site Y1 & minimum value were recorded N.D Y3 premonsoon season analyzed N.D.D.L <0.005 mg/l (non detectable). Tiwari [1] in 2016 reported lead in Ganga River ranged between N.D to 0.160.

Electrical conductivity: the maximum value were analyzed in 648 G2 monsoon season & minimum value analyzed 243 in site G3 premonsoon season. In 2018 Bhuri Singh et al reported EC value range between 1022 – 1776 [3].

Chloride: maximum value were analyzed 137 mg/L in monsoon season in site G1 & minimum value analyzed 35 mg/L premansoon season in site Y2. Tiwari [1] reported chlorine content in Ganga River in kaushambhi district range between (7.08 to 20.00) slightly lower than present study. While on other hand, higher chlorine content 170 to 310 reported by Bhuri Singh 2018.

In this study were found physiochemical parameter higher in monsoon season compare to pre monsoon season. pH, lead, EC, chloride, alkalinity, TDS, total hardness of river water increased during monsoon due to flood, it washes solid waste which mix with rain water and enter the rivers.

Table 5: Microbial Parameter Total coliform count & Faecal coliform count

Pre monsoon site	TCC Cfu/100 ml	FCC Cfu/100 ml	Monsoon Site	TCC Cfu/100 ml	FCC Cfu/100 ml
Y1 PRE	1.32×10^3	1.70×10^2	Y1 POST	2.876×10^4	7.20×10^2
Y2 PRE	2.56×10^3	2.84×10^2	Y2 POST	3.450×10^3	2.45×10^2
Y3 PRE	1.45×10^3	2.45×10^2	Y3 POST	3.300×10^4	2.56×10^2
G1 PRE	1.80×10^3	2.11×10^2	G1 POST	2.300×10^3	5.78×10^2
G2 PRE	2.20×10^3	1.56×10^2	G2 POST	4.500×10^4	6.50×10^2
G3 PRE	1.58×10^3	1.45×10^2	G3 POST	2.100×10^3	3.42×10^2

Total coliform count & Faecal coliform count

In microbiological study Ganga and Yamuna river of pre monsoon and monsoon season Tcc and Fcc were found higher in mansoon season. maximum value were analysed Tcc (3.300×10^4) Cfu/100 ml G3 site & Fcc (7.20×10^2) Cfu/100 ml site. Isolated bacteria in Ganga and Yamuna site (*Escherichia.coli, E. vulneris, Pseudomonas arginosa, Salmonella typhi, Citrobacter braachi, Proteus mirabilis*.)

Kaur & Verma (2014) reported total coliform count 4×10^4 in yamuna river and isolated different micoorganism (*Neisseria mocosa, Neisseria fluavcens, Proteus mirabillis, lactobacillus fermentum*). on other hand isolated microbes of ganga river (*Neisseria mucosa, Proteus mirabillus*, lactobacillus fermentum). while on other hand *Singh et al* reported total coliform count 15000 to 780000 [3].

Table 6: Microscopic & Biochemical characterization of Isolated bacteria

	E.coli	*P.arginosa*	*S.typhi*	*C.braachi*	*P.mirabils*	*E. Vulnaris*
indole	positive	negative	negative	negative	negative	negative
Methyl red	+positive	negative	positive	negative	positive	positive
Vogas Proskar	negative	negative	negative	negative	negative	negative
citrate	negative	positive	positive	positive	positive	negative
nitrate	positive	positive	positive	positive	positive	positive
catalase	positive	positive	positive	negative	positive	negative
H2s	negative	negative	positive	positive	positive	negative
L.A	negative	positive	positive	positive	negative	**postive
oxidase	negative	positive	negative	negative	negative	negative
TSI	positive	positive	positive	positive	positive	positive
Peptone	negative	positive	positive	positive	negative	negative
motality	motile	motile	motile	motile	motile	motile
Gram stain	negative	negative	negative	negative	negative	negative
shape	rod	rod	rod	rod	rod	rod

**: delayed positive

Table (7) : Water Quality index of Different sites Ganga and Yamuna

Pre monsoon site	WQI	Water Quality	Monsoon Site	WQI	Water Quality
Y1 PRE	69.683	Poor	Y1 Monsoon	80.362	V. Poor
Y2 PRE	62.599	Poor	Y2 Monsoon	79.865	V. Poor
Y3 PRE	64.378	Poor	Y3 Monsoon	74.990	Poor
G1 PRE	58.591	Poor	G1 Monsoon	75.205	Poor
G2 PRE	54.595	Poor	G2 Monsoon	75.685	Poor
G3 PRE	57.902	poor	G3 Monsoon	70.026	poor

In this investigation, the water quality of the Ganga and Yamuna sites was assessed, revealing a range of poor to very poor water quality. During the pre-monsoon season, the Water Quality Index (WQI) was found to range between 54.59 to 69.68, indicating poor quality. Conversely, in the monsoon season, the WQI ranged from 70.02 to 80.36, categorizing the water quality as poor to very poor. The highest WQI value was observed during the monsoon season at site Y1, while the lowest value was recorded during the pre-monsoon season at site G2. It is important to note that water of poor quality is unsuitable for drinking and domestic use, and is only suitable for industrial and irrigation purposes. Water of very poor quality is only suitable for irrigation purposes.

CONCLUSION

During the pre-monsoon and monsoon periods, the physiochemical water quality of the Ganga and Yamuna rivers was found to be of poor to very poor quality. The microbial load, specifically total coliform and fecal coliform, exceeded the prescribed limits set by the Bureau of Indian Standards (BIS) and the World Health Organization (WHO) by more than 100 times. Pathogenic bacteria, known to cause severe skin illnesses, gastrointestinal problems, and waterborne diseases, were also isolated from the water. Consequently, the water of the Ganga and Yamuna rivers was deemed highly contaminated and unsuitable for drinking, domestic, and industrial purposes. Therefore, it is imperative to conduct regular monitoring of the water quality of the Ganga and Yamuna rivers.

REFERENCES

1. Tripathi, I.P, Dewivedi P.O, (2016) Analysis of ganga river water sample collected from kaushambi District, Uttar Pradesh. Int. J. Eme. Tre. Mul. Vol 2, DOI:10.9790/2402-1207022834
2. APHA. (2000). Standard methods for the examination of water and wastewater.890.
3. Kaur, I and Verma D. D, (2014) Physiochemical and Microbiological Study Of River water of Ganga & Yamuna. Asi. J. Sci & Tec. Vol. 5:669-673
4. Singh, B., Khan, S., & Shahjahan, (2018) Assessment of water quality on the yamuna river using principal component analysis: A case study. Int. J. Res. & Ana. Rew. Vol. 5:951-954
5. Arora, N.K, Tewari, S, & Singh S (2013). Analysis of water Quality parameter of river ganga during maha kumbha, Haridwar, India Jou. Envi. Bio. Vol.34:799-803
6. Sing RP (2018). Microbilogy. Kalyani Publisher (4).
7. Trivedi, R.K & Goel, P. K. (2010). Chemical and biological methods for water pollution studies. Washington, DC: American Public Health Ass.(pp. 10–12) Karad, India: Environmental Publications.

8. Brown, R. M., McClelland, N. I., Deininger, R. A., & Tozer, R. G. (1970). A water quality index: Do we dare? Water & Sewage Works, 117, 339–343.
9. Brown, R., Mcclell and, N., Deininger, R., & Oconnor, M. (1972). A Water Quality Index – Crashing The Psychological Barrier doi:10.1007/987-1-4684-2856-8_15
10. Bureau of Indian Standards (BIS). (2012). Specification for drinking water IS10500:2012, New Delhi, India.
11. Raja PA. (2008). Evolution of physical and chemical parameters of River Kaveri, Trichy. Indian J. Environ. Biol. 29: 756-768.
12. Dalal L.P., Kalbende S.P., Nisal R.S.(2013). Assessment of Water Quality of River and the Hydro-biological Study of Algae. Int. J. Sci. & Eng. 12: 1: 45-54
13. WHO (2017) guidelines for drinking water quality.