

Assessment of Physico-Chemical and Microbiological Water Quality of The Kshipra River at Triveni During Mass Bathing Events

Jitendra Deavatwal ¹

¹ Research Scholar, Department of Chemistry, Mansarovar Global University, Sehore, M.P., India.

Dr. Upma Mishra ²

² Supervisor, Department of Chemistry, Mansarovar Global University, Sehore, M.P., India.

ABSTRACT

Mass bathing degrades water quality at the sacred Triveni site of the Kshipra River, where the Khan River mixes and conveys Indore's municipal waste. Yearly water samples were obtained in summer, monsoon, and winter. Sampled were three large Shanivari Amavasya mass bathings. Before, during, and ten days after each event, samples were obtained. For physico-chemical parameters, analyses followed APHA standards. Microbiological analysis comprised membrane-filtered total, faecal, *E. coli*, and *Streptococcus*. SPSS was used to statistically analyze indicators and calculate Oram's WQI to monitor water quality variations.

Keywords: *Pollution, Coliforms, Bathing, Water, Quality.*

I. INTRODUCTION

Environmental and manmade causes quickly contaminate clean, pure, and safe water in nature. Most river pollution comes from agricultural runoffs and industrial effluents containing antibiotics. Antibiotics cause antibiotic resistance and environmental changes. Antibiotic buildup in the environment helps bacteria adapt to generate antibiotic-resistant genes.

Organic contamination of riverwater and riverbanks is a global issue. *E. coli*, a commensal coliform of people and animals, enters the river by livestock activities, feces, and human septate. These bacteria may concentrate in river silt and spread antibiotic-resistant genes via horizontal gene transfer. Antibiotic-resistant microorganisms are found in freshwater worldwide.

In India, river water is revered and mass bathing in certain rivers is an ancient ritual. River Kshipra supplies household water to Ujjain City and surrounding areas. Kshipra River's religious significance draws big and small mass gatherings, including mass bathing, year-round. Massgathering is a scheduled gathering of over 1000 people for a set time. Ujjain attracts pilgrims from throughout India for river bathing during these large gatherings. Religious rituals include mass swimming in this river for a 'holy-dip'. In addition to bathing in the river, they swallow a handful of "holy water." When they bathe or drink river water, they may absorb antibiotic-resistant germs. Pilgrims spread antibiotic-resistant genes worldwide.

Several Indian rivers have antibiotic-resistant microorganisms. To control antibiotic resistance in rivers, it's vital to understand the function and dynamics of antibiotic resistance in river water during large gatherings. Antibiotic resistance levels in Indian mass bathing rivers are poorly known. Mass gathering and bathing have not been researched on the antibiotic resistance pattern in bacteria in river Kshipra, Central India, water and sediment. Our goal was to examine and correlate the antibiotic susceptibility pattern and total load of commensal E.coli from river-water and river-sediment pre-, during-, and post-mass bathing events in river Kshipra. We also assessed water quality physicochemical characteristics during these incidents.

II. REVIEW OF LITERATURE

Raghuvanshi, Deependra & Reddy, P. (2018) In this experiment, fifteen water quality indicators were used to construct water quality index (WQI) at three sites along the Kshipra River basin in Ujjain, Madhya Pradesh, India, during summer 2017. Three study sites provided 12 water samples for analysis. In addition to baseline data, the Water Quality Index standardized and integrated data. Based on BIS/ICMR/WHO acceptable limits, a rating system is created. To measure human-drinking water quality, WQI was computed. After standard treatment and disinfection, Triveni Sangam (Station 1) surface water was somewhat potable.

Gupta, R et al., (2013) This document discusses River Kshipra's water quality, its evaluation using the Water Quality Index (WQI), its pollution causes, and ways to recover it. According to M.P. Pollution Control Board and WQI statistics, its water quality is medium to poor. The research shows that Khan River water pollutes the Kshipra. Implementing a sustainable management plan, sewage planning, watershed management, and appropriate dilution flow will reduce River Kshipra pollution.

Gupta, R.C. et al., (2013) River Kshipra in Ujjain city receives a lot of untreated sewage everyday, and the water quality is poor during low flow season. This research employed the stream water quality model QUAL-2Kw to simulate dissolved oxygen sources and sinks and their interactions. The model was calibrated and tested, and simulated results match River Kshipra water quality. This research found that the QUAL-2Kw model can accurately guide River Kshipra river water quality management.

Trivedi, Seema & Karode, Anupriya. (2015) Aquatic planktons are tiny yet vital to the food chain. Plankton are the principal energy source and nutrient supply in freshwater ecosystems. The 2014 research will focus on the Kshipra River in Ujjain, M.P. The APHA/Prescott technique was used to collect, count, and identify plankton. Bacillariophyceae dominated Kshipra River phytoplankton.

III. MATERIALS AND METHODS

Indian rivers like Kshipra are respected. It originates from a Vindhya range hill one mile south of Kshipra village, 12 km southeast of Indore. It travels north across the Malwa plateau around 22040'–23050' latitude and 75045'–75035' longitude. Triveni is Kshipra river hub. Distance from start: 56 km. Important swimming place. River Khan carries Indore's water waste to Khipra. The site features Shani Temple and cremation. The page depicts flower dumping and bather customs. This study collected monsoon, winter, and summer mass bath water samples. Three big mass baths on Shanivari Amavasya—the first moon day for 10 days, samples were obtained before, during, and after mass

bathing. Total, faecal, E.coli, and Streptococcus were isolated using APHA. Sterile water bottles were used to transport microbiological samples to the lab in an ice box. The samples were membrane-filtered on Maconkey Agar and Brilliant Green medium after dilution to 103. Water samples were collected in sterilized plastic containers for physico-chemical analysis per APHA guidelines. Physical, chemical, and microbiological properties were linked using SPSS. Water Quality Index was calculated using Mr. Brain Orams WQI Index, consumer support group online calculator.

IV. RESULTS AND DISCUSSION

This study examined how mass bathing affected Kshipra river water quality during Shanivari Amavasya (1st of moon day on Saturday) in several seasons at the Triveni study location. Values were compared pre- and post-mass bath. Water and air temperatures changed seasonally. Air temperature was 16.60–25.40C. Similarly, water was 13.40–21.60C. November had the lowest values and March the highest. Temperature reduces water D.O., lowering oxygen for respiration and affecting aquatic life instantly. It affects chemical reactions and reaction rates in water, influencing usability. Water buffering was shown by alkaline pH (7.7–9.0) throughout the study. The pH increased during and after mass bathing. USEPA (1975) recommended pH 6.5–9.0, irrigation 5.5–9.0, and domestic use 7.0–9.9 for aquatic life protection.

The Kshipra river's mass bath dissolved oxygen content was 4.4–6.0 mg/lit. in March, 4.2–5.6 mg/lit. in July, and 4–6.4 mg/lit. in November. DO dropped during and after declines but rebounded over time. Microbial decomposition of pilgrims' organic, household, and biodegradable wastes utilizes oxygen and produces CO₂, lowering DO during and after mass bathing. Mass bathing reduces DO, according to Brahmsarovar, Haryana researchers. Kulshrestha and Resracher found similar patterns in Ganga. WHO advised DO > 5.0 mg/l. Most Triveni water DO was below acceptable, especially after mass bathing. Aquatic life needs on dissolved oxygen, and most organisms get stressed below 4–2 mg/lit. DO dropped during and after the downturn, but it stabilized and returned to normal after some time. Sharma et al. (2010) in Ganga river and Bhatnagar and Sangwan (2009) in Bramhsarovar pond revealed DO content drop during and after dips. However, Kshipra river DO is below standards before and after mass baths, indicating significant pollution.

Mass bath hardness was 216–356 mg/litre in March, 286–356 in July, and 364–492 in November. As bathers used soaps and other preparations, dipping made them harder. Summer mass baths were hardest, followed by monsoon and winter. The river's increased hardness and calcium levels after the festival may be due to the extensive bleaching powder and lime added to the sediments during holy bath preparation. March total alkalinity was 321–361 mg/lit., July 272–378 mg/lit., and November 254–354 mg/lit. Mass bath Kshipra River chlorides were 96.9–129.8 mg/litre, 109.8–131.86 in July, and 81.91–134.86 in November. Calcium was 72.35–84.96 mg/lit in March, 80.16–93.78 in July, and 65.73–88.17 in November. Total alkalinity, calcium, and chloride increased after mass bath. High organic materials and animal contaminants like ashes and peeing increased water chloride and ammonia.

Biological oxygen demand measures aerobic microorganism-degraded organic materials in water. This study found that BOD was increased after and throughout the drop, suggesting pollution. Summer BOD rates were highest, followed by monsoon and winter mass bathing. It was 23.2-43.6 mg/L. Godavari River has similar BOD trends.

Table 1: Physico-Chemical and Microbiological Parameters During Mass Bathing in March at Triveni Study Site of Kshipra River

Parameters	Pre Dip (28 Feb)	During Dip (1 Mar)	2 Mar	3 Mar	4 Mar	5 Mar	6 Mar	7 Mar	8 Mar	9 Mar	10 Mar
Date	28 Feb 2014	1 Mar 2014	2 Mar	3 Mar	4 Mar	5 Mar	6 Mar	7 Mar	8 Mar	9 Mar	10 Mar
Atmospheric Temperature (°C)	29.2	27.9	28.2	28.6	29.5	30.1	29.4	29.8	30.6	30.9	31.2
Water Temperature (°C)	26.1	25.7	25.9	24.8	26.2	26.4	25.9	26.2	26.4	26.4	26.5
Transparency (cm)	67	45	43	48	50	52	53	55	56	58	58.25
Turbidity (NTU)	25	40	39	39	35	32	31	28	26	26	25
pH	8.0	8.2	8.2	8.2	8.2	8.2	8.1	8.1	8.0	8.0	8.0
Carbonate (mg/l)	13	17	17	17	16	14	14	13	13	12	12
Bi-carbonate (mg/l)	308	348	344	334	326	319	316	316	313	313	310
Total Alkalinity (mg/l)	321	365	361	351	342	333	330	329	326	325	322
Chloride (mg/l)	96.90	128.87	124.87	123.8	119.8	114.8	111.8	107.8	105.8	103.8	102.8
Calcium (mg/l)	72.14	87.37	88.17	84.96	81.76	80.16	78.55	77.75	76.95	74.54	75.35
Total Hardness (mg/l)	216	348	342	340	336	326	316	314	310	308	306
Dissolved Oxygen (mg/l)	6.0	4.4	4.6	4.8	5.2	5.2	5.2	5.4	5.8	6.0	5.8
Biological Oxygen Demand (mg/l)	26.2	37.2	39.6	39.2	38.4	36.8	33.6	32.2	30.8	29.2	27.8
Chemical Oxygen Demand (mg/l)	74.2	122.6	123.2	122.4	120.2	117.4	113.8	108.6	99.4	95.6	88.4

<i>E. coli</i> (CFU/100 ml)	125	310	390	400	360	312	278	227	178	143	132
<i>Streptococcus</i> (CFU/100 ml)	44	50	69	74	63	57	51	48	47	45	45
Total coliform (CFU/100 ml)	225	495	593	692	606	590	512	464	390	312	282
Faecal coliform (CFU/100 ml)	180	370	470	483	423	370	329	273	225	200	200

Table 2: Physico-Chemical and Microbiological Parameters During Mass Bathing in July at Triveni Study Site of Kshipra River

Parameters	Pre Dip (25 Jul)	During Dip (26 Jul)	27 Jul	28 Jul	29 Jul	30 Jul	31 Jul	1 Aug	2 Aug	3 Aug	4 Aug
Date	25 Jul 2014	26 Jul 2014	27 Jul	28 Jul	29 Jul	30 Jul	31 Jul	1 Aug	2 Aug	3 Aug	4 Aug
Atmospheric Temperature (°C)	28.3	29.0	28.5	28.1	28.8	29.1	28.6	28.5	28.2	28.1	27.8
Water Temperature (°C)	24.2	24.5	24.3	24.0	24.4	24.8	24.7	24.3	24.1	23.8	23.4
Transparency (cm)	37.0	24.2	25.9	30.6	33.8	35.6	36.9	38.2	36.5	40.8	37.0
Turbidity (NTU)	37	48	48	46	43	42	40	38	38	38	38
pH	8.5	8.9	8.8	8.6	8.6	8.4	8.3	8.3	8.2	8.2	8.3
Carbonate (mg/l)	22	30	28	28	26	26	24	22	20	22	22
Bi-carbonate (mg/l)	250	346	350	344	334	328	320	322	314	310	310
Total Alkalinity (mg/l)	272	376	378	372	362	354	344	344	334	332	332
Chloride (mg/l)	109.89	127.87	126.87	124.87	121.87	116.88	114.88	113.88	111.88	109.89	109.89
Calcium (mg/l)	81.76	92.18	88.17	86.57	84.96	83.36	83.36	81.76	81.76	80.16	80.16
Total Hardness (mg/l)	286	350	346	338	338	340	334	310	302	290	290
Dissolved Oxygen (mg/l)	5.6	4.4	4.4	4.8	4.4	4.8	5.0	5.2	5.6	5.6	5.8

Biological Oxygen Demand (mg/l)	36.4	42.8	42.6	41.8	38.8	37.4	35.8	35.2	34.8	34.8	34.4
Chemical Oxygen Demand (mg/l)	106.8	138.6	137.2	130.4	126.8	122.2	116.4	118.8	118.2	112.2	104.6
<i>E. coli</i> (CFU/100 ml)	110	318	408	356	306	266	216	170	144	138	126
<i>Streptococcus</i> (CFU/100 ml)	35	52	79	70	66	60	54	46	43	38	38
Total coliform (CFU/100 ml)	300	466	590	674	596	544	540	460	426	358	334
Faecal coliform (CFU/100 ml)	160	370	440	496	472	438	410	382	315	260	262

Table 3: Physico-chemical and Microbiological Parameters During Mass Bathing in November at Triveni Study Site of Kshipra River

Parameters	Pre Dip (21 Nov)	During Dip (22 Nov)	23 Nov	24 Nov	25 Nov	26 Nov	27 Nov	28 Nov	29 Nov	30 Nov	1 Dec	2 Dec
Date	21 Nov 2014	22 Nov 2014	23 Nov	24 Nov	25 Nov	26 Nov	27 Nov	28 Nov	29 Nov	30 Nov	1 Dec	2 Dec
Atmospheric Temperature (°C)	22.2	20.2	19.9	20.3	19.8	17.4	18.6	17.2	16.6	16.8	16.6	16.2
Water Temperature (°C)	19.2	18.3	17.4	17.5	17.2	15.2	15.4	15.1	14.5	14.4	14.2	14.0
Transparency (cm)	73.2	32.0	33.4	34.6	38.6	42.4	46.7	60.6	75.4	79.2	79.5	79.7
Turbidity (NTU)	20	38	37	33	29	24	22	23	24	21	19	18
pH	7.7	8.3	8.3	8.2	8.0	8.0	8.0	8.1	7.8	7.8	7.9	7.9
Carbonate (mg/l)	12	24	26	25	22	20	16	16	15	16	14	14
Bicarbonate (mg/l)	242	300	308	302	284	270	254	248	250	246	240	238
Total Alkalinity (mg/l)	254	324	334	327	306	290	270	264	265	262	254	252

Chloride (mg/l)	84.91	119.88	109.89	114.88	99.9	94.90	95.90	92.90	93.90	89.9	82.91	81.91
Calcium (mg/l)	67.33	84.16	81.76	78.55	77.75	73.74	70.05	71.34	68.93	68.13	66.53	65.73
Total Hardness (mg/l)	362	464	472	466	402	394	390	386	384	374	366	364
Dissolved Oxygen (mg/l)	6.2	4.8	4.6	4.8	5.2	5.2	5.6	6.0	6.0	6.0	6.2	6.2
Biological Oxygen Demand (mg/l)	23.2	38.6	39.2	36.4	32.2	28.8	27.4	29.2	26.6	26.2	25.4	24.8
Chemical Oxygen Demand (mg/l)	65.4	102.8	104.6	98.2	90.4	86.6	82.4	76.8	72.2	69.4	68.8	66.4
<i>E. coli</i> ($\times 10^3$ CFU/100 ml)	100	215	316	290	256	214	196	147	132	126	114	110
<i>Streptococcus</i> ($\times 10^3$ CFU/100 ml)	60	79	84	82	77	73	69	66	70	68	65	59
Total coliform ($\times 10^3$ CFU/100 ml)	350	572	552	525	500	475	425	390	362	312	272	275
Faecal coliform ($\times 10^3$ CFU/100 ml)	170	300	405	380	325	300	289	228	202	196	175	168

Table 4: Water Quality Index During Mass Bathing at Triveni Study Site of Kshipra River

Date	Occasion	Pre Dip	During Dip	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
22 Nov 2014	Shanivari Amavasya	27	21	21	22	24	24	25	24	24	26	26	27
26 Jul 2014	Shanivari Amavasya	20	17	17	19	19	20	21	21	22	22	22	21
1 Mar 2014	Shanivari Amavasya	25	22	22	22	22	23	23	24	25	24	25	25

River Kshipra had high BOD during the inquiry. Chemical oxidation oxygen demand (COD). Organic stuff with plenty of biologically resistant substances frequently surpasses BOD. COD ranged from 64.6 to 142.4 mg/litre during and after decrease in this investigation. Chaturvedi et al. (2003) observed that an abundance of organic molecules and incomplete oxidation may increase COD. The findings were far greater than the 10 mg/l drinking water COD guideline. Transparency and turbidity

affect light penetration. That research found transparency between 25.9 and 56cm. Decline reduced transparency. Turbidity was 20-51 NTU. Turbidity increased microbial growth, dissolved solids, and nutrients. March summer mass baths exhibited more turbidity than winter ones due to low depth and rapid sewage flow.

Feces coli and Streptococcus are the most prevalent contaminants. In March, Kshipra river had 110X103-442X103 CFU/100, July had 110X103-408X103, and November had 104X103-348. March feces Streptococci scores were 44X103-86X103 CFU/100, July 150X103-425, and November 150X103-425. March feces is 180-512X103CFU/100 ml, July 160-510, and November 150-425. March had 225X103-718X103 CFU/100 total coliform, July and November 150X103-425X103. These microbial indicator species increased during and after dips, suggesting mass bath river contamination. Ancient Indian rituals like holy dips and mass washing in the Ganga harm rivers.

WQI was 21-27 during November mass bath, 17-22 in July, and 22-25 in March, suggesting excessive pollution. Water quality declines during and after mass bathing (Table-5). Sharma et al. (2014) discovered 32–42 WQI values in Hindon river U.P. and classed all regions as lacking water quality. Temperature, turbidity, total alkalinity, total hardness, BOD, COD, E.coli, Strepto-coccus, FC, and TC were positively correlated, while DO and transparency were negatively correlated with pH, total hardness, BOD, COD, E. Bhor et al. (2013) found that human contamination of Godavari river Maharastra water sources may cause

Worldwide, industrial effluents, agricultural runoff, mining, and sewage damage water, including India. However, sacred practices and human activities pollute India. Mass baths pollute our sacred waterways by increasing nutritional levels, organic and inorganic contaminants, and pathogenic microorganisms. Millions of pilgrims mix settled silt, clay, and sand with surface water, increasing river soil hardness, calcium, chloride, alkalinity, and other metals. After mass baths, all physicochemical and microbiological parameters rose, but the river's self-purification recovered them after a while. However, CPCB (1995) indicated bathing water total coliforms under 500, DO 5mg/lit. or greater, and BOD 3mg/lit. or fewer. CPCB classifies Khipra river water as D because it fails certain standards.

V. CONCLUSION

This Triveni Kshipra River study indicates that mass bathing events drastically change river water physico-chemical and microbiological parameters. Bathing increased turbidity, BOD, COD, and nutrient contents, indicating organic and anthropogenic pollution. Low dissolved oxygen strained the aquatic ecosystem. Total, faecal, E. coli, and Streptococcus rose considerably during and after mass bathing, suggesting human and ritual contamination. Untreated Khan River sewage and Triveni offerings and cremations pollute water. Water quality improved after the events, although it sometimes exceeded legal levels, raising public health concerns. Peak activity renders river water unsafe for human consumption, according to the Water Quality Index. Garbage disposal, public awareness, and ceremonial control maintain this precious river's environment.

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