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PHYSICOCHEMICAL PROPERTIES OF WASTEWATER IN THREE TYPICAL SEWAGE ACCUMULATED SITES OF KOTA DISTRICT OF RAJASTHAN

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ABSTRACT

The physicochemical qualities of the effluent samples of three Wastewater sites (Sazidehra site, Raipura site and Nayapura site) and one control site (Akelgarh site) in Kota district of Rajasthan, India were evaluated from three slots of time in the year i.e., September, December and March using standard methods. The physicochemical parameters assessed included color, odor, pH, temperature, total dissolved solid (TDS), turbidity (NTU), Biological Oxygen Demand (BOD), Chemical oxygen demand (COD), dissolved oxygen (DO) and Heavy metals. The results of the evaluation were as follows: temperature (28 ºC-36ºC), COD (17-92mg/L), and turbidity (1.96-286 NTU), BOD (2-7mg/l), DO (1-7mg/l) and TDS (175-1890mg/l). The temperature, TDS, turbidity, COD, DO were not found to be in the recommended limits. Some of the parameters exceeded from their normal ranges and some found to be below the range that ensure the contaminants present in the water and considering the samples unhealthy for drinking and highly polluted. The Raipura site was found highly contaminated. The heavy metals were concentrated in the research area, which suggests that the river is severely polluted. Zinc (Zn) was found highly (267ppm) accumulated in the sewage water of Raipura site. We conclude that these sewage dumping areas of water sources are polluted to their respective receiving watersheds and threats to public and environmental health.

***Keywords**: physicochemical, wastewater effluent, sewage treatment, pollution, BOD, COD*

Introduction

Industries and Municipal corporations often discharge their treated effluents back to the environment, most especially in the surface water environments. Untreated or inadequately treated municipal sewage and waste discharges may contain public health compromising pathogens and hazardous elements (e.g., heavy metals) and the chemical substances that could lead to hostile environmental effects such as alterations of aquatic organism behaviors and structure, this kind of pollution resulted in reduction of diversity of life on earth, diminishing

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the quality of recreational waters and shellfish harvesting zones, and polluting of water meant for consumption [1-2]. The heavy metals are produced from natural and anthropogenic sources and can build-up in sediments, having significant environmental implications for local communities, as well as for river water quality [3]. The water sources get contaminated by the flow of various industrial effluents into it, the ground waters are contaminated from landfill leachates, deep well liquid disposal, industrial wastes, etc. [4].

Apart from the adverse effect of these activities on the environment, the different levels of chemical and microbiological constituents in discharged wastewater effluent brought additional pressure to bear on the already stressed freshwater resources in many developing countries including India [5-6]. It has also been reported from several studies that the use of freshwater polluted by industrial and municipal effluents resulted negative impact on the irrigation of agricultural produce due to changes in the physicochemical properties of the watershed [7]. The toxic chemicals present in the contaminated water destroy the aquatic organisms, which in turn results in the disruption of the food chain and aquatic ecosystem [8]. Good quality surface water relies on various factors that includes the physicochemical parameters and the magnitude of the pollution load. The physicochemical characteristics of the water can reveal particular conditions for the ecology of aquatic organisms and suggest suitable conservation and management strategies [9-10]. Thus, industrialization has led to increased emission of pollutants into ecosystems. Therefore, this study has been carried out to assess a comparative study on physico-chemical parameters between polluted and non-polluted sites of river Chambal.

Materials and Methods

I. Study Area Description

The current research was directed in the largest state of India that is Rajasthan and particularly of the Kota district. Due to arid and semiarid climate and insufficient surface water resources, Rajasthan depends heavily on groundwater for drinking and for irrigation [11]. Availability of groundwater is deeper with high mineral concentrated chemicals which make the water unfit to drink. Sadly, the groundwater quality in most of the districts of Rajasthan is not bestowed to recommended standards. Kota is the biggest industrial city of Rajasthan state. It is well known for its major industrial network in and around the city. The Chambal River is the one and only perennial water from drinking and agricultural point of Region in Rajasthan. In addition, Chambal River is the fundamental resource of water necessary for various thermal, fertilizers, chemical and glass industries in Kota. Some of the well-known industries in Kota like Shri Ram Rayons, Shri Ram Fertilizers and Chemicals, Shri Ram Cement Works, Chambal Fertilizers and Chemicals Ltd., Kota Thermal Power Station, there are many other small and medium enterprises functioning in and around Kota which require a lot of water for their operation and maintenance [12]. Effluents from these industries contain N, P, K, heavy metals, organic and inorganic pollutants, and toxic colors. In Kota city, there are two water treatment plants in city,

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named as Akelgarh (270 MLD) and Mini Akelgarh (Sakatpura, 130 MLD) distributing about 390 MLD water to the public. Due to water treatments, contaminants are less at this site. Therefore, this site has been used as a control in this study. On the other hand, domestic waste, and wastewater from Nayapura Naala directly dump into the Chambal River near Chambal Bridge on NH12. Sazidhera Naala is situated in the middle of the city hence, all domestic waste, wastewater, and small industries waste from this Naala decants into the Chambal River before Kota barrage.

II. Water Sample Collection

Different water specimens of polluted and non-polluted sites (below mentioned) of river Chambal were collected in pre-sterilized bottle and Zip-lock plastic bag respectively according to standard procedures from American Public Health Association [13]. Standard methods were applied to check all physicochemical parameters.

III. Physicochemical Analysis

Selected physicochemical parameters such as color, odor, pH, temperature, turbidity, TDS, BOD, COD in the water samples were analyzed according to APHA,1995 and Trivedi and Goel, 1986. The DO parameter was analyzed according to Romanian Standard (SR ISO 5814,1990) [14-15].

IV. Heavy metals determination by AAS- Heavy metals are important for all living organisms in varying amounts, such as iron, copper, zinc, and cobalt, for proper growth. However, the excessive amount of these heavy metals can also produce toxic effects. Thus, the determination of the amounts of heavy metals is especially important where there is a risk of having anthropogenic influence on aquatic environment. Before analysis of heavy metals, water samples were filtered through Whatman filter paper no. 541 (Whatman, Germany) into 100 ml of prewashed plastic bottles and the analytical grade HCl was used to adjust water pH to 3.5. After that, the samples were kept in a room temperature until analysis. Cadmium (wavelength 228.8 nm), Chromium (wavelength 357.9 nm), Zinc (wavelength 217 nm), and Lead (wavelength 283.3 nm) specific hollow cathode lamps were used to analyze the samples. The instrument has a minimum detection limit of 0.01 mg/l for Cd, 0.10 mg/l for Cr, 0.03 mg/l for Zn, and 0.2 mg/l for Pb in the flame method. Samples were aspirated through nebulizer and the absorbance was measured with a blank as a reference. Calibration curve was obtained using standard samples (containing 0.5, 1.0, 1.5 and 2 mg/l for Cd, 0.5, 1.0, 2.0, and 3.0 mg/l for Cr, 0.2, 0.4, 0.8,1.0 and 2.0 mg/l for Zn, 1.0, 2.0, 4.0,

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8.0 and 10.0 mg/l for Pb). The correlation coefficient was found for Cd 0.998, for Cr 0.999, for Zu 0.999, and for Pb 0.999. The sample was diluted many folds to keep the results in the analytical range. The heavy metals (Pb, Cd, Cr, and Zn) concentrations in all samples were determined by atomic absorption spectrophotometer (AAS) (Model AA-6800, Shimadzu Corporation, Japan) using an air-acetylene flame with digital read-out system [16, 17, 18].

V. Statistical Treatment of Data

The data obtained were analyzed using descriptive statistical analysis at a 95% confidence interval. SPSS was used for the one-way analysis of variance (IBM SPSS version 20), mean, and range. t-Test was used to test variations among all possible pairs of treatments. Correlation was performed using the Pearson procedure of SPSS.

Results and Discussion

The results of the physicochemical qualities of the wastewater samples are presented in various Tables obtained from the data of various sites of testing.

I. Analysis of Physicochemical parameters

In the present investigation, water samples were collected from four sites (one was the control site) of the Kota district to determine various physiochemical parameters that were described as follows:

At Akelgarh site, the observations were made on various parameters that was shown in Table-1. In the control site (Akelgarh), the parameters were obtained within or around the standard range depicting the pH range from 7.0-8.5 with no odour, Temperature from 28°C to 36°C, BOD 2-2.7 mg/l whereas the content in COD was observed from 5-8.12mg/l. The level of DO was found 5mg/l to 7mg/l. The quantity of TDS varied between 175 mg/l to 193 mg/l. The visualization in terms of turbidity varied from 1-4 in terms of NTU (Nephelometric Turbidity Unit). All parameters were showed variations according to the months. At Sazidehra site, the pH range obtained was in between 7.7 to 8.7, temperature between 29°C to 34°C. The odour was pungent, the standard level of BOD was 1.5 mg/l, whereas in our study it was reported between 2.64 mg/l to 3.88 mg/l, due to effluent discharge on the site.

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COD obtained was 39 mg/l to 50 mg/l (10 times increased from the standard range). The level of DO was found in range 3.03 mg/l to 4.62 mg/l. The quantity of TDS was found to be very far from the standard value in all three months and varied between 329 mg/l to 390 mg/l. Similarly, the visualization in terms of turbidly varied from 15-25 in terms of NTU which was very high from standard value and unacceptable (Table-2). At Raipura, pH range was observed in between 7.7-8.4, temperature 29°C to 33°C. The odour was very pungent, BOD was recorded in range 4.93 mg/l to 6.54 mg/l whereas, COD was observed from 77 mg/l to 99 mg/l which was very high as compared to standard values, resulting from the elevated organic discharge in water body. The level of DO was 1.28 mg/l to 2.70 mg/l and quantity of TDS varied between 530 mg/l to 1890 mg/l. The visualization in terms of turbidity varied from 122-286 in terms of NTU (Table-3). At Nayapura, site the variations were observed in all parameters in comparison to other sites. The pH ranges obtained were from 6.3 to 8.9. The temperature was found very high ranges from 21 to 38°C. The odour of Nayapura water sample was mild pungent odour. The level of BOD as comparison to standard was found high i.e., 4.10 mg/l to 5.75 mg/l whereas, the content in COD was observed between 27 mg/l to 55 mg/l. The level of DO was observed between 2.04 mg/l to 3.64 mg/l. The quantity of TDS varied between 355 mg/l to 390 mg/l. The visualization in terms of turbidly varied from 9.67-23 in terms of NTU (Table-4).

Table-1: Periodic physiochemical parameters of water estimated at Akelgarh site

AKELGARH											
S. No.	**Water Parameters**	**Std. (IS-10500)**	**September**			**December**			**March**		
			A1	**A2**	**A3**	**A1**	**A2**	**A3**	**A1**	**A2**	**A3**
1.	Colour	Colourless	Colourless								
2.	Odour	Odorless	Odourless								
3.	Temp (°C)	34	32±2.32	33±2.19	34±2.25	28±2.08	29±2.11	30±1.96	34±2.18	36±2.96	35±0.17
4.	pH	6.5-8.5	7.6±2.33	8.2±1.18	7.8±0.92	8.1±2.68	8.3±3.41	7.4±0.59	7.9±1.99	7.0±1.34	7.5±1.02
5.	BOD (mg/l)	1.5	2.1±0.11	2.5±0.35	2.6±0.05	2.2±0.94	2.4±0.08	2.3±0.004	2.0±0.10	2.7±0.56	2.6±0.41
6.	COD (mg/l)	4.0-6.0	5.3±0.89	5.0±1.92	6.2±1.09	6.9±2.11	6.4±1.32	8.6±1.15	9.10±0.86	9.53±2.94	10.12±1.02
7.	DO (mg/l)	4.0-6.0	5.9±0.08	6.0±1.19	6.2±2.06	6.7±1.58	6.5±1.91	6.2±2.33	6.9±3.1	7.0±2.81	6.8±0.88

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8.	TDS (mg/l)	500-2000	176±1.43	183±1.56	179±1.26	181±2.28	186±2.13	188±2.25	175±1.02	191±1.11	193±1.13
9.	Turbidity (NTU)	1.0-5.0	2 ±0.29	1±0.5	1.9±0.09	2.1±0.04	4.1±0.11	3.3±0.21	4±0.81	3±0.55	1.8±0.49

A1, A2, A3-Three sites at Akelgarh

Table-2 Periodic physicochemical parameters of water estimated at Sazidehra site

SAZIDEHRA											
S. No.	**Water Parameter**	**Std. (IS-10500)**	**September**			**December**			**March**		
			S1	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**
1.	Colour	Colourless	Colorless								
2.	Odour	Odorless	Pungent odour								
3.	Temp (°C)	34	30±1.31	29±1.29	32±1.34	31±0.88	30±0.92	33.11±0.99	30±1.29	31±1.27	34±1.22
4.	pH	6.5-8.5	7.7±2.38	7.8±1.91	8.0±3.35	8.6±0.92	8.2±2.66	8.5±1.08	8.7±1.43	8.2±2.09	8.4±3.71
5.	BOD (mg/l)	1.5	3.88 ±0.071	3.81±0.035	3.69±0.085	2.91±0.98	2.78±0.004	2.64±0.18	2.85±0.51	2.81±0.009	2.89±0.81
6.	COD (mg/l)	4.0-6.0	50±2.27	47±2.19	48±2.22	43±1.17	40±1.23	45±1.22	39±2.36	41±2.31	44±2.35
7.	DO (mg/l)	4.0-6.0	4.62±0.08	4.40±0.67	4.57±1.07	3.03±0.36	3.61±0.71	3.29±1.83	3.14±1.25	3.22±0.99	3.07±0.13
8.	TDS (mg/l)	500-2000	390±4.23	383±3.87	373±2.82	341±3.05	355±1.46	339±3.49	329±0.91	335±1.81	343±4.23
9.	Turbidity (NTU)	1.0-5.0	21±0.66	25±1.23	23±0.89	15±0.54	18±0.77	20±0.39	21±1.2	23±0.79	22±1.69

S1, S2, S3- Three sites at Sazidehra

Table-3 Periodic physicochemical parameters of water estimated at Raipura site

RAIPURA											
S. No.	**Water Parameter**	**Std. (IS-10500)**	**September**			**December**			**March**		
			R1	**R2**	**R3**	**R1**	**R2**	**R3**	**R1**	**R2**	**R3**
1.	Colour	Un objectionable	Light white/ Milky	Milky	Milky	Light white / Milky	Milky	Light white/ Milky	Milky	Light white/ Milky	Light white/ Milky
2.	Odour		Very Pungent odour								
3.	Temp (°C)	34	32±1.88	33±1.91	32±0.90	30±1.78	29± 1.15	29±1.46	33±2.95	31±2.02	31±3.83
4.	pH	6.5-8.5	8.4±0.56	8.0±1.12	8.1±0.74	7.9±2.18	7.7±1.59	7.9±0.88	7.8±3.19	8.0±3.88	7.9±0.91
4.	BOD (mg/l)	1.5	6.32±1.8	6.21±0.05	6.54±1.26	5.7±2.81	5.31±2.07	5.79±3.19	5.19±0.009	5.04±1.47	4.93±0.68

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5.	COD (mg/l)	4.0-6.0	88 ±1.56	90±1.61	86±1.48	87±1.52	91.50±1.35	85±1.43	77±0.35	79±2.44	81±3.46
6.	DO (mg/l)	4.0-6.0	2.85±0.05	2.70±0.09	2.21±0.41	1.08±0.03	1.51±0.50	1.59±0.39	1.28±0.01	1.31±0.53	1.45±0.004
7.	TDS (mg/l)	500-2000	887 ±4.33	1141±2.08	1890±4.01	750±2.21	1784±1.83	1604±4.77	530±3.41	618±1.9	1401±3.67
8.	Turbidity (NTU)	1.0-5.0	179 ±2.18	325±1.10	156±0.27	122±2.13	205±1.53	201±3.05	286±1.03	180±0.85	145±0.19

R1, R2, R3- Three sites at Raipura

Table-4 Periodic physicochemical parameters of water estimated at Nayapura site.

NAYAPURA											
S. No.	**Water Parameter**	**Std. (IS-10500)**	**September**			**December**			**March**		
			N1	**N2**	**N3**	**N1**	**N2**	**N3**	**N1**	**N2**	**N3**
1.	Colour	Un Objectionable	Colorless								
2.	Odour		Mild Pungent odour								
3.	Temp (^{o}C)	34	23±0.88	21±1.62	25±0.19	24±2.89	26±0.70	22±0.58	38±1.19	37±1.61	35±3.00
4.	pH	6.5-8.5	7.1±1.93	7.8±2.29	6.3±1.18	8.6±3.08	6.6±0.92	8.2±0.63	7.0±1.44	8.9±1.02	6.8±2.59
5.	BOD (mg/l)	1.5	5.71±0.012	5.67±0.99	5.75±1.27	4.90±1.83	4.85±0.19	4.69±0.59	4.32±2.12	4.36±0.05	4.10±0.093
6.	COD (mg/l)	4.0-6.0	36±1.10	31±1.23	27±1.19	35±1.07	38±0.29	38±1.72	55±2.06	53±2.31	55±2.85
7.	DO (mg/l)	4.0-6.0	3.64±0.08	3.52±0.13	3.41±1.06	2.90±1.36	2.61±1.71	2.72±0.87	2.19±0.54	2.24±0.09	2.04±0.12
8.	TDS (mg/l)	500-2000	345±3.88	378±3.14	367±4.46	360±3.75	355±3.46	359±2.49	387±2.91	380±1.81	390±4.23
9.	Turbidity (NTU)	1.0-5.0	11±3.09	9.67±2.49	12±0.13	15±0.54	18±0.77	20±0.39	21±1.20	23±1.79	22±1.09

N1, N2, N3- Three sites at Nayapura

The temperature profile generally varies significantly ($P<0.05$). The temperature complied with set limits for discharged effluent for most of the sampling period due to the prevailing atmospheric conditions. High temperature may produce softening of bituminous joints and increase odour as a result of anaerobic reaction and can be deteropans to the pipe material itself [19], the temperature of the effluents may pose a threat to the aqua-based organisms. The pH values as observed in this study fell within the guideline limit for discharged effluents into a receiving waterbody, although there were variations at all the treatment plants in January and February, which may be due to increases in temperature during the summer season. The pH of the water is known to affect the availability of micronutrients as well as trace and heavy metals.

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The pH level of water defines its utility for a different purpose. It has been established that pH is a vital characteristic in assessing the acid-base level of water. Low or high pH has a toxic effect on aquatic life and alters the solubility of other chemical pollutants as well other important elements in surface water. This may lead to adverse effects on those that depend on it for various uses and also the ecosystem [20]. This suggests that there could be other unidentified contaminants gaining access to the watershed.

A high concentration of TDS could be lethal to aquatic organisms, leading to osmotic shock thereby, affecting the osmoregulatory strength of the organism [21]. The concentrations of TDS in irrigation water hinder plant growth, crop yield, and quality of product [22]. The TDS values obtained in this study are similar to those reported previously by [23]. DO is used to determine the level of pollution by organic matter and the demolition of organic substance, as well as the self-purification strength of water bodies. DO is a guide of physical and biological process in water. The acceptable standard for drink purposes is 6 mg/L and for aquatic organisms is 4-5 mg/L. DO in concentration in unpolluted water normally ranges from 8-10 mg/L [24]. Low DO in water disturbs the existence of fish by increasing their susceptibility to disease, migration, and reproductive behavior, hindering swimming capacity, fluctuating feed, and leading to death of aquatic life [25]. Inorganic compounds such as ammonia nitrites, hydrogen sulphates,
and Ferro ions also tend to decrease the oxygen in water. Biochemical oxygen demand is described as the amount of oxygen required to break down organic substances in water while COD is the amount of strong oxidant required to break down both organic and inorganic matters [26]. BOD in the aquatic system is caused by high levels of organic matters such as leaves and dead plants, animals, industrial effluents, wastewater treatment plants, food processing plants, woody debris, animal manure, and urban storm water runoff. High levels of BOD can be traced to heavy discharge of industrial effluents, domestic sewage, crops, and animal waste [27]. High levels of COD in water may point to poor water standards caused by municipal or farmed effluent discharges [28], which may in turn result in higher oxygen depletion that affects aquatic organisms [29]. The observation from this study agrees with Salem *et al.,* [30] for COD and BOD at the receiving watershed. Studies have shown that too much turbidity in water can lead to interference with some treatment steps at some stages, such as coagulation and separation solids of the water treatment techniques, which may increase treatment cost, and when extremely turbid water is chlorinated, there is a possibility for a rise in trihalomethane (THM) precursor formation [24]. Pipraiya *et al.* (2017) [31] reported the similar physicochemical parameters of Chambal River water at three locations that were chosen for sampling in his studies: Kota (Rajasthan), Dhoulpur (Rajasthan), and the boundary between Bhind and Etawa throughout the winter and summer seasons (2014-15). They concluded that at a chosen sampling station in Kota, several factors, including DO, call for close attention. The quality of the wastewater that industries at station Kota discharge needs to be strictly monitored. Gupta *et al.* (2011) [32] investigated the physicochemical assessment of the Chambal River's water quality in the Kota city area of Rajasthan state (India). They discovered that the average water quality parameter over the course of three years (2007–2009) was pH 7.5-8.25, turbidity 3.9–8.2 NTU, total alkalinity 112-148 mg/l, total dissolved solids (TDS) 180–219 mg/l, and total hardness 132-146 mg/l, DO (4.3–6.1 mg/l), COD (7.40–38.80 mg/l), and BOD (1.20–12.20 mg/l). They concluded that the river near Kota is moderately polluted as evidenced by the increasing levels of ammonia, BOD, COD, and low DO. Reddy and Baghel (2010) [33] investigated the effects of effluent from the chemical and textile industries on the physicochemical properties of the Chambal River. For each of the

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three seasons, water samples were taken quarterly. In accordance with the locations of the noteworthy industrial discharges into the river, five sampling stations were picked by them along the course of the river. The pH, BOD, and COD values slightly increased as a result of the effluent released into stations 2, 3, and 4. The findings of the t-test showed that there were significant differences in turbidity, TDS, TSS, electrical conductivity, DO, chloride, sulphate, and hardness between the several sites analyzed. With the exception of TDS, which varied dramatically among sampling times, season had no impact on many of these metrics. Ansari and Sharma, 2019 [34] periodically investigated the physicochemical parameters and heavy metals (Cd, Cr, Zn, Pb) of wastewater collected from three contaminated sites (Raipura, Sazidehra and Akelgarh) of river Chambal. The conventional techniques were used to analyze these physiochemical characteristics in our current study. Temperature ranged from 28 ºC to 36, and the pH of the soil and wastewater was found to be alkaline. It was discovered that the Raipura site was more contaminated, whereas the sites in Sazidehra had the highest OC content. The permitted limit established by the World Health Organization and the United States Environmental Protection Agency was exceeded by the studied physicochemical characteristics.

II. Analysis for the presence of heavy metals

Due to unplanned industrial growth, and accumulation of sewage waste without sufficient treatment, and other factors, some portions of the river Chambal are severely poisoned. One of the main contributors to water pollution is the environmental contamination caused by industrial waste. A variety of chemicals (Heavy metals), pathogens, and physical and sensory alterations like high temperature and discoloration were the specific contaminants that cause water pollution [11].

The phrase "heavy metals" refers to a set of metals and metalloids whose atomic density is found to be greater than 4 g/cm and 3 or 5 times or more, than that of water [35]. Fish and other aquatic organisms could be at risk from heavy metal contamination of aquatic ecosystems. Metals are known to affect a number of physiological and biochemical processes important for fish metabolism. From the perspective of water contamination, the most significant heavy metals needed to be studied; Zn, As, Cu, Pb, Cd, Hg, Ni, and Cr. Some of these metals, like Cu, Fe, Mn, Ni, and Zn, needed as nutrients in minute amounts by plants and microbes, but at higher concentrations, they become hazardous [36-37]. In the present study, the presence of heavy metals (Pb, Cd, Zn, and Cr) was screened in water samples collected from all four collection sites using AAS with seasonal effects.

At Akelgarh site (Control), The amount of Pb was found maximum in March months (0.548ppm), and Cd was found to be maximum in September (0.688ppm), Zn in December (208ppm) while Cr in March (1.256 ppm). At Sazidehra site, the amount of Pb was resulted maximum in September (3.227ppm), similarly Cd was found to be maximum in September (0.194ppm). Zn was found to be maximum in December (225ppm) while Cr in September (1.631 ppm). At Raipura site, the amount of Pb was observed maximum in September (4.321ppm), similarly Cd was found to be maximum in September (0.778ppm). Zn was found to be maximum in December (267.97ppm) while Cr was maximum in September (6.484 ppm). 3/4 heavy metals resulted to be maximum in the month of September. At Nayapura site, the amount of Pb was maximum in September (0.496 ppm), and the amount of Cd (0.073 ppm), similarly the amount of Zn was found highest in December (202.02ppm) and Cr in March (1.01ppm).

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Table-5 Mean concentration of heavy metals in different water sample (all data in ppm)

Water sample	Pb*	Cd*	Zn*	Cr*
Standard	0.05	0.005	5.0	0.05
Akelgarh-1(Sep)	0.511±0.06	0.688±0.08	200.211±2.26	1.118±0.12
Akelgarh-II(Dec.)	0.297±0.04	0.039±0.007	208.347±2.24	0.334±0.05
Akelgarh-III(March)	0.548±0.08	0.299±0.04	198.577±1.89	1.256±0.2
Sazidehra I(Sep)	3.227±0.21	0.194±0.02	202.113±1.91	1.631±0.31
Sazidehra II(Dec.)	0.278±0.02	0.027±0.004	225.512±2.45	0.338±0.05
Sazidehra III(March)	1.528±0.112	0.089±0.01	212.405±2.31	0.798±0.09
Raipura I(Sep)	4.321±0.25	0.778±0.09	197.023±1.78	6.484±0.88
Raipura II(Dec.)	2.128±0.119	0.036±0.007	267.976±2.58	1.814±0.34
Raipura III(Mar)	3.825±0.23	0.468±0.06	207.088±2.22	4.358±0.42
Nayapura I(Sep)	0.496±0.02	0.052±0.01	194.623±1.34	0.641±0.08
Nayapura II(Dec)	0.441±0.04	0.073±0.03	202.02±1.45	1.002±0.01
Nayapura III(Mar)	0.395±0.02	0.033±0.002	187.924±2.98	1.01±0.060

WHO maximum permissible (mg/l) limit 2008 [38]

Ansari and Sharma, 2019 [34] periodically investigated the physicochemical parameters and heavy metals (Cd, Cr, Zn, Pb) of wastewater collected from three contaminated sites (Raipura, Sazidehra and Akelgarh) of river Chambal. The maximum concentration of heavy metals was at Raipura sites (Pb, Cd, Cr, Zn). In the summers of 2019-21[39], samples were taken from various polluted industry sites along the Jojari River. Dubey (2021) [39] studied the levels of heavy metals in the Ganga's water and sediments. Iron (Fe), Chromium (Cr), Lead (Pb), Nickel (Ni), and Zinc (Zn) were measured in water and sediment samples, taken from various places (Zn). These heavy metals were concentrated in the research area, which suggests that the river is severely polluted. This point indicates natural and anthropogenic sources, were among the many potential sources of these heavy metal contaminants. When compared to national and international organizations like the WHO and USEPA, the quantities found were higher and above the maximum permissible and recommended limit.

The status of heavy metal contamination and health concerns related to the usage of water from the river Gomti by millions of people were evaluated by Khan *et al.* in 2021 [40]. The degree of contamination (Cd) value was determined to be high, indicating "high" danger levels as a result of heavy metal contamination in the river Gomti. Singh and Sao (2015) [41] assessed the Hasdeo

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river's water quality in sarvamangla nagar, Korba (Chhattisgarh). They assessed the water quality parameters (temperature, pH, DO, BOD, COD, and level of heavy metal contaminants) to determine the pollution level. Heavy metal pollution was seen by them in the following order: Fe>Pb>Cd>Zn. Although, in our study Zn was found in higher concentration (Table-5).

Conclusions

The current study assessed the water quality of wastewater disposal sites and the characterization of various physicochemical parameters. The results showed compliance of effluent quality for some parameters while a few among others did not comply with set limits for most of the sampling period. The Raipura site was found highly contaminated. The heavy metals were concentrated in the research area, which suggests that the river is severely polluted. Zinc (Zn) was found highly accumulated in the sewage water of Raipura site. This study revealed a general deterioration in the physicochemical qualities of the discharged wastewater effluents as well as the receiving watershed and suggests the inefficiency of the treatment works at producing effluents of acceptable quality together with its attendant environmental health challenges. The findings underscore the need for continuous pollution monitoring and intervention strategies to curb indiscriminate pollution of environments by the continuous release of inadequately treated effluents in Kota city of Rajasthan, India, and many other developing countries in order to forestall public health concerns associated with environmental pollution.

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