RESEARCH ARTICLE

Physicochemical Characteristics of Sewage Water of Bilaspur City for Suitability for Irrigation Purposes

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Abstract

The increasing demand for water due to population growth and globalization has led to sewage or wastewater being used to irrigate crops. Irrigation with reused water has favorable effects on crops but also poses a threat to the ecosystem, soils, underground water, and human life. This research article presents an analysis of the physicochemical characteristics of sewage water in Bilaspur City to determine its suitability for irrigation purposes. The study involved collecting and analyzing water samples from ten sampling sites in the city. Results showed that the water had acceptable pH and salinity (Chloride). However, it has high turbidity, electrical conductivity, and biochemical oxygen demand, indicating poor quality of water. The levels of essential plant nutrients, such as nitrogen, phosphorus, and potassium, were found to be within the acceptable range for agricultural use. Statistical analysis was performed, and Karl Pearson's coefficient was determined and analyzed for various physicochemical parameters. The study concludes that the sewage water in Bilaspur city may be suitable for irrigation purposes after appropriate treatment and management. This research provides valuable insights for policymakers and municipal authorities in promoting sustainable wastewater management practices for agricultural purposes.

Keywords: Wastewater utilization, Physicochemical Parameters, Land Irrigation, Micronutrients, Statistical Analysis.

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Introduction

Water is a critical resource that is essential for survival, and it is alarming to see the extent of water pollution and wastage that is taking place. Mankind has opted for groundwater for quick and safe consumption due to the severity of contamination and the degradation in both the quality and amount of surface water. In the last few decades, India has witnessed substantial and overall growth in almost every field, including industry, technology, and agriculture. But as a negative consequence, it has significantly affected the quality of water, due to which human health is threatened by most of these development activities. According to the Central Water Commission (CWC) India has a potential water supply of about 1999.20 billion cubic meters (BCM), which naturally flows into the rivers. It makes up only 4% of all river water in the planet (Vijayshankar, 2023). However, the topographical constraints and an uneven distribution over time and place, only around 1123 BCM of the total annual water potential can be used successfully. 433 BCM of groundwater and 690 BCM of suitable surface water can be used for this purpose (Tran *et al.*, 2018). As a direct or indirect factor, the growth of a plant is dependent on water quality, the nature of the soil and the degree of maturity of the plant during harvesting (De Corato, 2020). Considering the scarcity of freshwater, wastewater is increasingly being used for agricultural irrigation. It significantly affects the hydrology and water quality of natural water bodies. Poustie *et al.* reported that treated wastewater (TWW) includes various organic and inorganic elements that may benefit (such as nitrate) or harm (such as salt) plants (Poustie *et al.*, 2020). Consequently, it could impact the food production of the world if treated wastewater irrigation is used for utilization. They concentrated on how the presence of antibiotics, functional NPs, micronutrients like N and P, some trace elements (metals), and the presence of ions affected crop growth. Future changes to wastewater discharge and the use of these toxic substances could result in phytotoxicity, particularly for antibiotics. The concentration of some of the xenobiotics in wastewater can inhibit plant development. The most significant benefit caused by the presence of nutrients in treated wastewater, could be outweighed by the harmful effects of salt, as high salt concentrations are deleterious to plant growth. India has a huge responsibility to maintain the environment and the public health for a constantly growing population and inadequate hygienic facilities. Wang *et al.* examined recent developments in Indian wastewater disposal and reutilization regulations and compared the results with techniques used abroad (Wang *et al.*, 2017). The lack of risk assessment, insufficient institutional capacity, and the absence of a consensus phase in standards-setting cause uncertainty and hesitation in sectoral development. Phased/graded techniques must be integrated into enforcement mechanisms. Studies on the effects of recycled water use on crops and assessments of the risks to the environment, soils, underground water, and human population have been conducted. The results suggest a beneficial effect of irrigation with wastewater on crop development and yield

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due to exposure to the additional nutrient contents of reused water. When the traditional water supply becomes scarcer, treated wastewater will be used for irrigation and agriculture. Regular assessment and further analysis of the damaging effects of reused water irrigation are necessary because of the environmental threat posed by this practice. To extend the above studies, we selected Bilaspur city of Chhattisgarh and studied the physicochemical parameters of the sewage water. Bilaspur is next to the capital city of Chhattisgarh state, popularly known as 'Nayaydhanee', achieving a higher economic status. The Arpa river (the lifeline of the city) serves as the source for the disposal of commercial and municipal wastewater in Bilaspur. The climatic change has already turned the perennial Arpa river into a non-perennial river, whereas the drains containing domestic/municipal wastewater of this city are being discharged untreated into the Arpa river (Parashar, 2015). In this context, this course of investigation extensively studied the physicochemical analysis of municipal wastewater in Bilaspur. This study focuses on the physicochemical properties of sewage water in Bilaspur and analyzes its suitability for irrigation. The uniqueness of this study is based on the fact that it provides a comprehensive statistical analysis of sewage water, which is an essential aspect of determining its suitability for irrigation. The findings of this study have significant implications for sustainable agriculture practices and water management policies in urban areas, making it an important and relevant addition to the existing literature.

Materials and Methods

Study Area

The coordinates of Bilaspur are 22.09°N 82.15°E. It is 264 feet above sea level on average (866 ft). Bilaspur is situated on the banks of the Arpa river, which is rain fed and originates from the Maikal range in Central India. Like any other Indian community, there is a severe lack of a sewerage and drainage system, and as a result, even the first monsoon shower causes widespread flooding. Several collecting points collect rainwater and wastewater from diverse locations under different conditions. Other than manual separation, there is minimal wastewater treatment at any location. A survey of wastewater status in Bilaspur city was determined by dividing the city map of Bilaspur, Chhattisgarh into five sectors, two sampling sites from each sector resulted in 10 sampling sites, as shown in Figs 1, 2, and 3 (Showing map of India, Chhattisgarh state, Bilaspur district, respectively).

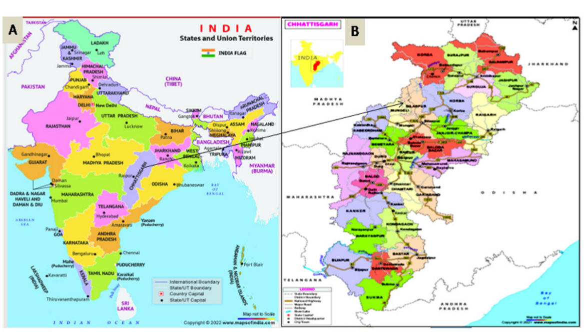

Fig. 1: A) Map of India and B) chhattisgarh

Fig. 2: District map of bilaspur, chhattisgarh

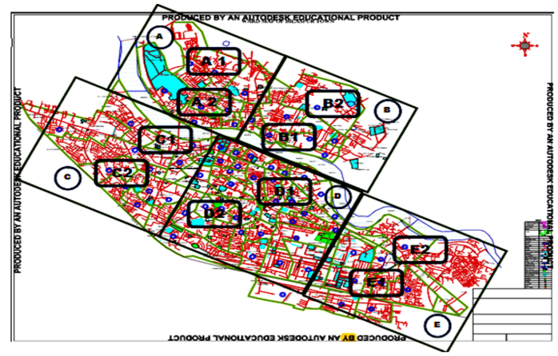

Fig. 3: Sectorwise city map of Bilaspur city

The ten wastewater collection sites are designated as S1, S2, S3, S4…….S10 and shown in Fig. 4 A-J (photographs showing sampling sites of Bilaspur City). They are A. Jawalinala; B. Chingrajpara; C. Lingyadih, D. Sanichari, E. Torwa, F. Pacharighat, G. Dabripara, H. Jarahabhata, I. Kududand, J. Dhuripara. All of them discharge in the Arpa River.

Sampling

During the period from January 2022 to December 2022, a comprehensive study was conducted to evaluate the quality of water of the selected sites. The water samples were collected on the 15th day of each month, and were analyzed on-site for pH, temperature, and dissolved oxygen (DO) using the Systronics water analyzer 371. After collection, the samples were filtered using Whatman 42 filter paper, securely packed in high-grade polythene bottles, and transported to the laboratory for further inspection. The samples were labeled correctly and stored in the refrigerator until the laboratory analysis. The various parameters, including turbidity, electrical conductivity, total alkalinity, free CO_2, total acidity, biological oxygen demand (BOD), chemical oxygen demand (COD), chloride, total hardness, Ca-hardness, Mg-hardness, NO_3-N, NO_2-N, and total PO_4 were analyzed using spectrophotometric and other standardized methods in accordance with the guidelines provided by the American Public Health Association (APHA). Evolution™ 220 was used for spectrophotometric estimations.The chemicals utilized in this study were of analytical grade, and double-distilled water was used to prepare the solutions of required normality. Each sample was replicated three times and the mean were determined.

Statistical Analysis

We analyzed the data and found correlations between the parameters studied using the Microsoft Excel 2007 program.

Fig. 4: Photographs showing sampling sites of Bilaspur City, A) Jawalinala; B) Chingrajpara; C) Lingyadih; D) Sanichari; E) Torwa; F) Pacharighat; G) Dabripara; H) Jarahabhata; I) Kududand; and J) Dhuripara

This will improve our understanding of their relationships and lead to more accurate conclusions.

Results and Discussion

The results of the evaluations of the wastewater from these sampling sites are as follows.

Temperature

Due to fluctuations in the climate and other environmental conditions, the water temperature varies daily and seasonally and is indicated in Fig. 5. The standard temperature pressure (STP) average water temperature varies from 19.0 to 32.2°C. The minimum temperature was observed in December 2021 and the maximum was recorded in June 2021.

Acidity (pH)

Fig. 2 displays the pH data for each of the ten sites (10) under investigation. The pH of the collected sewage water varied from 6.3 to 8.4. The minimum pH recorded was 6.3 in November 2022 for site 10 and a maximum of 8.4 for site 3in April 2022. The majority of the sampling locations showed pH levels below

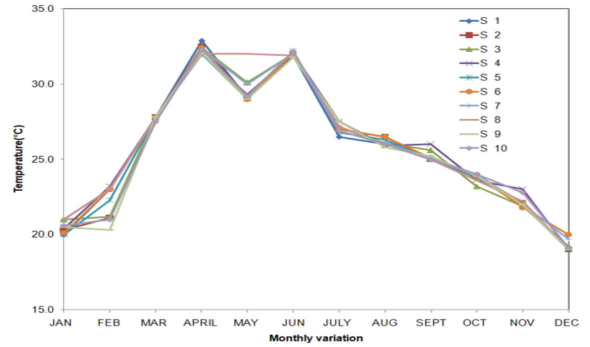

Fig. 5: Mean Monthly variations in temperature (°C) of city sewage water of Bilaspur city at different sampling sites

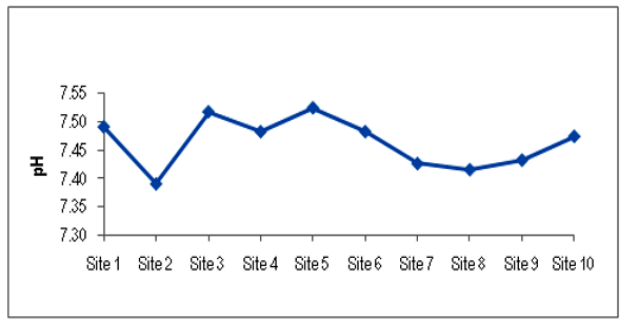

Fig. 6: Mean variation in pH of city sewage water of Bilaspur city at different sampling sites

the WHO-recommended range for pH (6.9–9.2). The mean pH values indicated that the water was slightly alkaline. A higher pH at some locations was due to bicarbonates and calcium and magnesium carbonates in the water because of the area's geological features. The relatively higher pH readings in the summer may be due to the CO_3^{2-} and HCO_3^- rich sewage effluents surge compared with the rainy season (Kelly *et al.*, 2020). Sewage water is more acidic during the hot summer months and less acidic during the cooler winter months. Additionally, locations with higher levels of rainfall tend to experience more fluctuations in acidity due to the increased dilution of sewage water. The dilution effect is most likely responsible for the water's relatively low pH (6.1–7.0) during the rainy season. Reports of a comparable nature have recently surfaced (Yasmin *et al.*, 2023). The variation in the average pH at 10 sampling sites is shown in Figs 6 and 7.

Electrical Conductivity

Electrical conductivity (EC) measures the concentration of solubilized ions (salinity) in water, producing the hardness. High levels of inorganic contamination are present in a water body with a high conductivity. The salinity of agricultural soils can be caused by specific ions in water. Water that has high salinity is unsuitable for irrigation and household usage. The EC values of all the 10 sampling sites ranged between 280–6504 µS/cm as shown in Figs 8 and 9. The highest value was obtained in February, while the lowest was in August. The high ionic conductivity in the area may be due to various factors such as solid waste disposal, effluent discharge, and runoff from farms. The dilution impact of water has resulted in low EC values of water during the rainy season (Akhtar *et al.*, 2021). The majority of the data for 10 sampling sites during the year was considerably

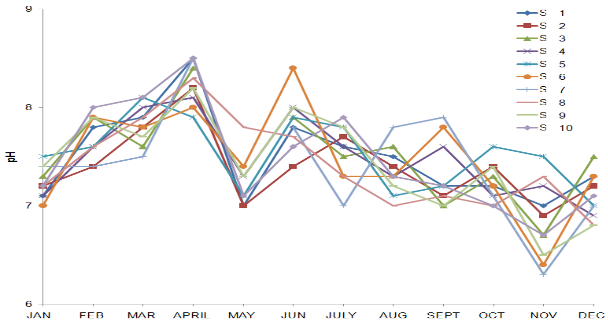

Fig. 7: Monthly variations in pH of city sewage water of bilaspur city at different sampling sites

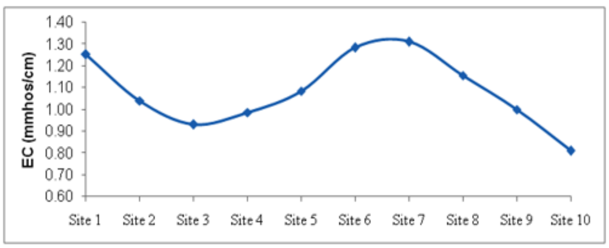

Fig. 8: Mean variation in EC (mmhos/cm) of city sewage water of bilaspur city at different sampling sites

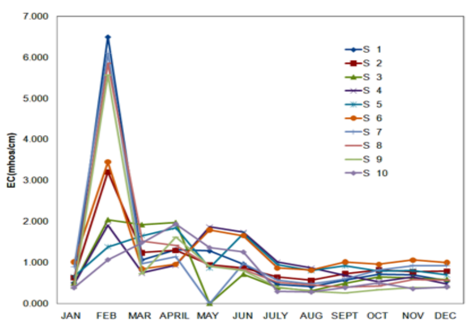

Fig. 9: Monthly variations in EC (mmhos/cm) of city sewage water of bilaspur city at different sampling sites

higher than the 500 mhos/cm. It exceeds the upper permissible limit decided by the World Health Organization (WHO). The minimum was observed for Site 10.

Turbidity

The loss of clarity is referred to as the turbidity of the water sample, resulting in less light penetration. The average turbidity of the sewage water of all ten sites was within the range of 6.7 to 61.7 Nephelometric turbidity unit (NTU) as indicated in Figs 10 and 11. The mean turbidity values were (20.6 ±11.38) to (61.7 ± 12.29) NTU. For irrigation and drinking uses, all values are above the permissible limit, which affects photosynthesis. Our findings concur with other reports that found turbidity greater during the dry season than during the wet season (Vinh and Ouillon, 2021; Yasmin *et al.*, 2023). The measured turbidity readings were higher than the threshold of 1 NTU for household water consumption as recommended by WHO (WHO, 2011). The turbidity of the wastewater increases during the monsoon season due to a surge in suspended particles in water due to rainfall. The lowest turbidity was obtained for the sampling site 10.

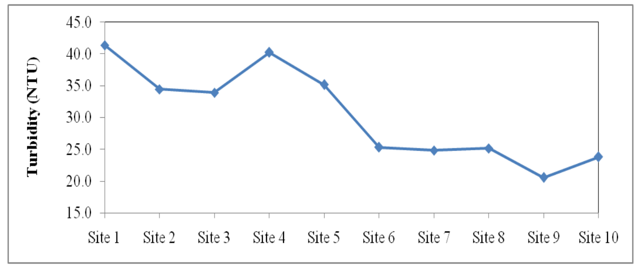

Fig. 10: Mean variations in turbidity (NTU) of city sewage water of bilaspur city at different sampling sites

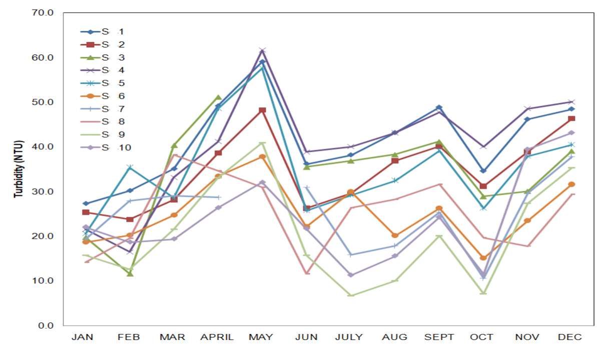

Fig. 11: Monthly variations in turbidity (NTU) of city sewage water of bilaspur city at different sampling sites

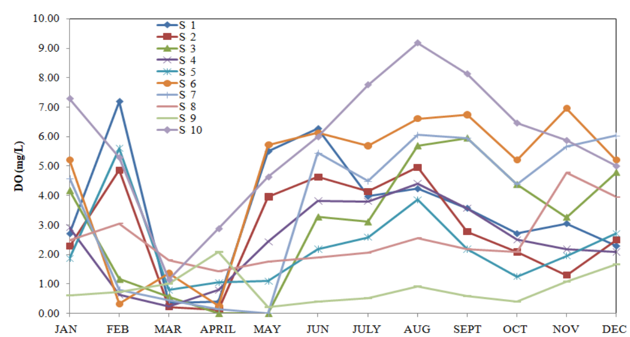

Fig. 12: Monthly variations in dissolved oxygen (mg/L) of city sewage water of bilaspur city at different sampling sites

Measurement of DO, COD, and BOD

The average DO value of the sewage water of all the sampling sites collected from January 2022 to December 2022 is depicted in Fig. 12. The amount of dissolved oxygen in sewage water varies significantly with the season, with higher amounts in the winter and lower amounts in the summers. Similar observation has been reported by other research groups (Matta *et al.*, 2017).

The graph clearly shows that the monthly variations in DO values of the sampling sites varied between 2.65 to 7.23 mg/L and below the permissible range of 6.5 to 8 mg/L (Dieter and Chorus, 2023). It might be the result of excessive phosphorus and nitrogen-induced algal development. Dissolved oxygen is utilized during the death and decomposition of algae. The less dissolved oxygen implies that insufficient oxygen was accessible for living things. The sewage generated from organic and agricultural wastes, residences, hospitals, and city waste was most likely the cause of the BOD increase (Wang and Zhang, 2020). The rise in BOD levels is likely a sign that pathogenic and drug-resistant coliform bacteria are becoming more prevalent.

Similar research found that the BOD levels exceeded the WHO-recommended permitted limits (Ayandiran *et al.*, 2018). The amount of oxygen consumed by bacteria and other microbes during the decomposing organic matter is measured by BOD. They are frequently employed to assess the effects of organic biodegradable effluents, such as those from wastewater treatment plants in cities and food and vegetation. A higher amount of oxygen demand suggests the possibility of a higher dissolved oxygen deficit when the macrobiotic breaks down the organic materials in the sewage. The absence of harmful or non-degradable pollutants or the existence of pure water was indicated by the extremely low oxygen demand. The BOD/COD ratios ranged between 0.21 to 0.52 mg/L for the sewage water collected from various sites. It demonstrates that a significant amount of the organic matter is biodegradable (Dasgupta and Yildiz, 2016). Table 1 and Fig. 13 depict the experimental BOD and COD data for sewage water. The relationship between BOD and COD may be expressed using the following linear regression equation.

$$BOD = 0.316\ COD + 1.862$$

The correlation coefficient (R^2=0.38)suggested a moderate positive correlation between BOD and COD.

Chloride

Human activity appears to be the main cause of high chloride concentrations in our country. Contamination from sewage water and other sources is responsible for this issue. It denotes inefficient sewage disposal, dumping waste close to a water source, residential effluents, and water leakage from septic tanks into underground water. The elevated chloride level is attributed to anthropogenic. The results show that chloride at each sampling site ranged from 44.53 to 117.05 mg/L and was within the permissible value of 250 to 1000 mg/L in drinking water. Similar range has been reported earlier (Batabyal and Chakraborty, 2015).

Total Acidity, Total alkalinity and Free CO_2

The mean total acidity value of the sewage water collected from the sampling sites was in the range of 10.68 to 42.39 mg/L. Total alkalinity arises from the soluble metal ions of calcium, magnesium, sodium, potassium, ammonium, and iron salts in the form of carbonates, bicarbonates or sometimes hydroxide ions(Jørgensen, 2000). Alkalinity measures the ability of water sources to withstand pH fluctuations. The carbonate/bicarbonate buffers produce greater alkalinity subsequently high amounts of acids or bases can be detected in water with higher alkalinity without changing the pH. Carbonic acid is produced when carbon dioxide reacts with water and dissociates to generate HCO_3^- and CO_3^{2-}. The increase in the number of protons (H^+) results in a reverse shift in the equilibrium, releasing carbon dioxide. The presence of carbonates ($CaCO_3$) in water causes bicarbonate levels to increase naturally. The average alkalinity ranged from 307.64 ± 235.62 mg/L to 659.10 ± 493.98. Alkalinity is more prevalent during the rainy season than in the winter (Dey *et al.*, 2021). High free carbon dioxide values indicate the presence of substantial organic matter in wastewater (Jindal and Sharma, 2011).

Table 1: The mean BOD and COD values of the ten sampling sites

BOD	*COD*	*BOD/COD*
34.96	100.57	0.35
32.61	106.52	0.31
38.69	148.04	0.26
46.60	124.44	0.37
80.98	154.80	0.52
26.31	111.89	0.24
38.50	79.23	0.49
22.31	101.93	0.22
50.23	186.14	0.27
29.62	94.92	0.31

Total Hardness

The hardness in water is due to the presence of HCO_3^- and CO_3^{2-}, SO_4^{2-}, Cl^-, of Ca^{2+} and Mg^{2+} ions in dissolved form. Total hardness should range between 200 to 600 mg/L. According to Fig. 14, the total hardness varies between 276.26 to 340.43 mg/L and is permissible. Hardness levels did not exhibit a consistent seasonal trend throughout the study region. In the summer season, the hardness of the water increases due to the temperature rise and salt concentrations brought on by increased evaporation.The highest seasonal total hardness was observed in summer, while the lowest was recorded in winter. Numerous comparable results have already been published (Renuka *et al.*, 2014; Dey *et al.*, 2021).

Micronutrients NO_3/NO_2-N and Total Phosphate

Nutrients play a crucial role in irrigation and significantly impact various aspects of plant growth, including reproduction and metabolic processes (Waraich *et al.*, 2011). The primary factors determining the nutrient distribution are the time of year and freshwater runoff from land. Nitrite-nitrogen is one of the common pollutants found in sewage water, and it can cause eutrophication of water bodies, adversely affecting aquatic life. Nitrite-nitrogen is a marker for the presence of organic

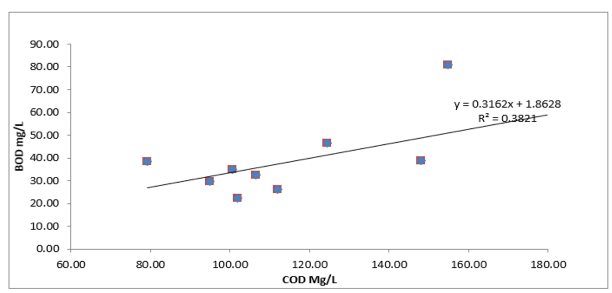

Fig. 13: The regression diagram for the ratio of BOD/COD

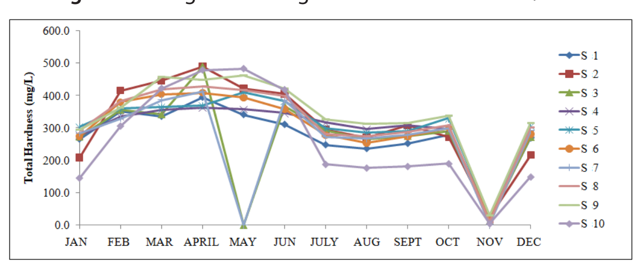

Fig. 14: Monthly variations in total hardness (mg/L) of city sewage water of bilaspur city at different sampling sites

Table 2: Correlation matrix amongst various physicochemical parameters

	pH	*Temperature*	*Turbidity*	*EC*	*Cl*	*T. Al*	*FCO_2*	*TH*	*DO*	*COD*	*BOD*	*NO_3-N*	*PO_4*	*NO_2-N*
pH	1.00													
Temperature	-0.15	1.00												
Turbidity	-0.10	0.85	1.00											
EC	-0.05	0.45	0.49	1.00										
Cl	0.60	0.06	0.10	0.64	1.00									
T. Al	0.34	-0.06	0.07	0.58	0.70	1.00								
FCO_2	-0.20	0.71	0.49	-0.07	-0.13	-0.41	1.00							
TH	0.02	-0.32	-0.13	0.30	0.20	0.61	-0.60	1.00						
DO	-0.09	0.21	0.07	-0.02	-0.01	-0.49	0.40	-0.76	1.00					
COD	0.51	-0.48	-0.38	-0.01	0.42	0.35	-0.45	0.69	-0.49	1.00				
BOD	0.62	-0.44	-0.37	-0.13	0.22	0.28	-0.49	0.24	-0.49	0.40	1.00			
NO_3-N	-0.31	-0.24	-0.24	-0.25	-0.29	-0.47	0.02	-0.61	0.80	-0.55	-0.35	1.00		
PO_4	0.34	0.21	0.22	0.64	0.49	0.51	-0.38	0.48	-0.07	0.35	0.05	-0.32	1.00	
NO_2-N	0.51	-0.48	-0.38	-0.01	0.42	0.35	-0.45	0.69	-0.49	1.00	0.40	-0.55	0.35	1.00

matter in sewage water. The high nitrite-nitrogen levels during the summer can be attributed to the higher temperatures and low values of DO in the sewage water (Bano *et al.,* 2022). These conditions promote the growth of nitrite-forming bacteria, resulting in high nitrite-nitrogen levels. In contrast, during winter, lower temperatures and reduced microbial activity lead to lower nitrite nitrogen levels (Rantanen *et al.*, 2018). At all ten sampling sites, the value of nitrate-nitrogen lies between 0.524 to 2.844 mg/L and the monthly variations are relatively similar at all sites as shown in Fig. 15. Seasonal changes in nitrate nitrogen levels in sewage water in India are an important environmental concern. As urban areas expand, the amount of wastewater produced increases, leading to high nitrate-nitrogen levels. Industrialization also leads to increased nitrate nitrogen levels, as industrial processes often require the use of nitrogen-containing

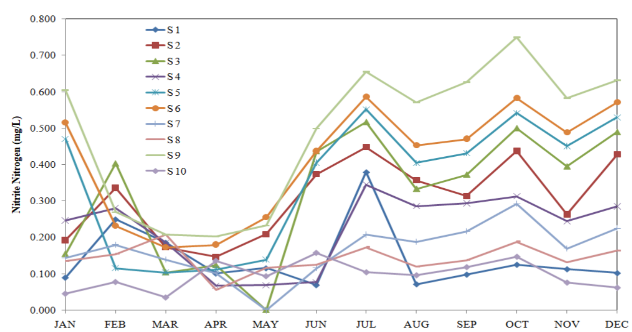

Fig. 15: Monthly variations in nitrate nitrogen (mg/L) of city sewage water of bilaspur city at different sampling sites

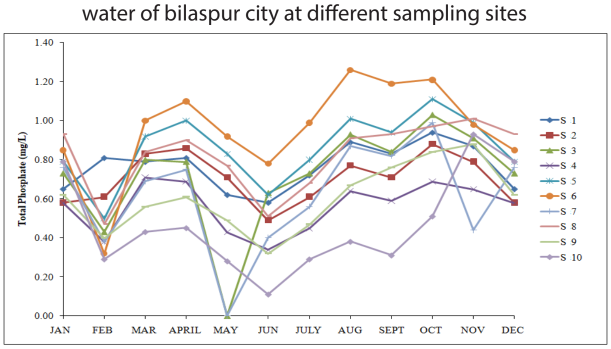

Fig. 16: Monthly variations in phosphate (mg/L) of city sewage water of bilaspur city at different sampling sites

chemicals, such as nitrates, nitrites, and ammonia(Razzak *et al.*, 2013). The higher nitrate nitrogen levels can be related to the increased runoff and precipitation during the monsoons, which leads to the transport of nitrogen-rich materials from agricultural fields and other sources into sewage water. It was low during the summer seasons. A similar observation has been made by Muhaidat *et al.* in evaluating NO_3^- and NO_2^-in TWW of Zarqa River (Jordan)(Muhaidat *et al.*, 2019).

Total phosphate is an essential micronutrient representing the amount of water's phosphorus. Phosphorus occurs in both organic and inorganic forms, but in sewage water it is in the form of inorganic phosphate. The estimation of orthophosphate is mostly performed in sewage analysis. Total phosphate measures the organic matter in the water and is a key indicator of water quality. High concentrations of phosphate can indicate the presence of human and animal waste, as well as other sources of organic matter such as fertilizers and detergents. Eutrophication, excessive algae growth, oxygen depletion, and aquatic life mortality due to nutrient depletion are all consequences of high phosphate levels in sewage water (Comber *et al.*, 2013). The PO_4^{3-} concentration varies, on average, between 0.11 and 0.126 mg/L (Fig. 16). For the sampling sites with higher phosphate value, it is attributed to food habits, washing, and so forth.

The collected sewage water was nutrient-rich which fluctuated during the period of investigation. The phosphate levels of sewage wastewater show high values in monsoon. The sampling sites with higher phosphate values may be due to an increase in domestic wastewater because of food, washing, and so forth (Popa *et al.*, 2012).

Statistical Analysis

A plethora of statistical tools are available to investigate the relationships between various variables. Regression and correlation examine the interactions between two variables. The relation between the several physicochemical characteristics of the sewage water was ascertained using Excel 2007 from Microsoft and was used to calculate the correlation coefficient. A correlation matrix of several parameters is depicted in Table 2.

The data in Table 2 reveal that pH showed positive correlations with Chloride (r=0.6), Total Alkalinity, COD, BOD (r=0.62), and NO_2-N. It is negatively correlated to Turbidity and Electrical conductivity (Sharma *et al.*, 2022). These observations match well with other reports (Shrivastava and Joshi, 2008; Selvaraju *et al.*, 2022). The temperature shows a strong correlation with turbidity (r=0.85), free CO_2(r=0.71),and electrical conductivity. A strong negative correlation between Temperature with BOD and COD can be found (Shrivastava and Joshi, 2008). COD and total hardness are positively correlated (El-Chaghaby *et al.*, 2020).The turbidity shows a strong correlation with Electrical conductivity and turbidity. Electrical conductivity is highly correlated to chloride (r= 0.64), total alkalinity (r= 0.58), and total phosphates (Hussain *et al.*, 2021). The results reveal that a significant and negative correlation between DO and total alkalinity, total hardness, COD, and BOD exists (Ahipathy and Puttaiah, 2006). The high level of these parameters indicates high amounts of organic/inorganic content in water bodies that increase BOD and COD levels, further accelerating the degradation rate and thus depleting the oxygen content(Prathumratana *et al.*, 2008). Nitrate-nitrogen is negatively correlated to pH and highly correlated to DO. The results were consistent with other reports(Das, 2022; Saalidong *et al.*, 2022).

Conclusion

It is important to address the issues of solid waste disposal, effluent discharge, and farm runoff in Bilaspur city for a safer and healthier environment. The comprehensive analysis of the data has revealed that the mean pH of the collected sewage, the electrical conductivity and the total hardness were within the permissible limits according to WHO and APHA. It is evident that wastewater having household pollutants degrades the sewage water quality, but essential micronutrients are also added and are beneficial for crop irrigation. Additionally, the highly polluted sewage sites recorded low pH values, and COD levels ranged were high.

Correlation analysis has been employed for wastewater of comparable origin to determine potential relationships between different parameters. We found strong positive correlations between several physicochemical parameters like total alkalinity and total hardness, COD and total hardness, and so on. pH and EC were negatively correlated. The results suggested that site 10 has more favorable parameters (high DO, less EC, low total alkalinity and total hardness, less total phosphate, etc.) for crop irrigation than other sites. An analysis of the physicochemical properties of sewage water in Bilaspur City suggests that it may have potential for use in irrigation activities. This data could provide valuable insights into the suitability of the water for agricultural purposes and help inform decision-making processes related to water management in the area.

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Authors Contribution

The article involved the conception and design of physicochemical analysis of sewage water of Bilaspur City for suitability for irrigation purpose. All authors have significantly contributed in the study. Nidhi Tiwari was responsible for the data collection process, which involved collecting and analyzing data from various sources. Dr. Ashish Tiwari was responsible for the analysis and interpretation of the results obtained from the data collected by Nidhi Tiwari. The data analysis process involved a thorough examination of the collected data, which was used to draw conclusions and make recommendations based on the research findings.

Finally, Dr. Ashish Tiwari was responsible for drafting the manuscript that would detail the team's findings and recommendations.

Dr. Uttara Tiwari's attention to detail was crucial in producing a clear, concise, and accurate manuscript. The team's findings and recommendations were accurately reflected.

Overall, the authors' work on this article has made a significant contribution to the field, and their efforts in study conception, data collection, analysis, and manuscript preparation have been crucial to the success of the research.

Conflict of Interest

None.

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