Impact of Textile Industrial Effluents on Water Quality of Bandi River, Rajasthan, India

Dr. Meena Rao

Associate Professor, Surendra Makwana, Maulana Azad University, Jodhpur, Rajasthan, India

Abstract: ***Textile industries and factories of Pali city release abundantly of pollutants that get mixed up with water sources of Bandi River. In the present study the impacts of textile industrial effluent on Bandi River water were studied at Pali city of Rajasthan that is industrial hub specially for the textile industry. The present status that the many physico-chemical parameters of river water are in excess of the standard levels and they were found to be higher in concentration. The soil sites near to river became polluted due to mixing of industrial effluents coming from textile industries located nearby Bandi River. Thus, the analysis of water became an apparent need for best agriculture practices. Results of current study analysis exposed significant alteration in the values of the parameters like pH, BOD, COD, TDS, TSS, Hardness, Cl^- and SO_4^{-2} from the range of standard values. On the basis of this observation, it can conclude that the textile industrial effluents are adversely affecting not only the water quality of river and but also affects the soil quality. The sampling sites Punayata and Mandia showed high deviation from standards. Thus, the present study concluded that the ground water quality in the study area was polluted. It also disturbs aquatic environment, features of ground water, agriculture land and human beings.***

Keywords: Bandi River, textile effluents, physico-chemical parameter, pH, BOD

1. Introduction

British poet W. H. Auden says "Thousands have lived without love, not one without water." All living being on Earth needs water to survive. Water is an essential component of all living organisms on the earth. Most of the water on this planet is stored in ocean and ice caps. Most of our demand for water is fulfilled by rainwater, which gets deposited on the surface of groundwater resources. Water is the most important component of our life. We cannot live without water. Any chemical or biological variation from normal composition leads to water pollution. Water of good quality is required for a living organism.

Water quality of Gulab Sagar pond, Jodhpur is changed due to anthropogenic activity (Makwana S.,2020). The wastewater contains different variety of chemicals from the various stages of operations which include printing, scouring, bleaching and dyeing (Deepali and Gangwar, 2010). Recently more than 800 industrial units are carrying out dyeing and printing of cotton and synthetic clothes on large scale (Rathore, 2012)**.** Many studies were carried out in order to assess the impact of textile dyeing effluents on the surface water quality. (Rathore, 2011).

Shellina Khan, Navneet Joshi (2019) reported that Textile industries of Jodhpur and Balotra cities of Western Rajasthan discharge plenty of pollutants that get mixed up with water bodies. Hence, it can be concluding that the concentration of effluents affects the soil quality. Meena L. R. and P. Nama (2017) concluded that the textile industrial effluents were adversely affecting on the river water quality, which affects on aquatic environment and human beings of surroundings.

According to Rituparna Sarkar Apurba Ratan Ghosh· Naba Kumar Mondal (2020) Analysis of physicochemical parameters is very essential and important to test the water before it is used for domestic, agricultural, industrial or any other purposes. Therefore, it is necessary that the quality of domestic and drinking water should be checked.

Water pollution is a major problem produced by industrial effluent in Pali, Rajasthan. The printing and dyeing industries cover a major portion of the industrial section in Pali. The textile effluent discharged through these industries is of toxic nature that was also noticed by Satish, *et., al*, (2008). Improperly treated wastewater from textile and dyeing industries of Pali affecting groundwater quality and its surrounding areas due to discharge of improperly treated effluent from CETPs.

Mishra P. and Soni R., (2016), The textile effluents containing dye, printing and processing waste water of Balotra region were collected to study the concentration levels of different salts and metal ions in the effluents. Untreated or incompletely treated textile effluent can be harmful to both aquatic and terrestrial life by adversely affecting the natural ecosystem and causing long-term health effects (Kant R., 2012). Typical indicators of untreated textile industry effluent often have extreme values of pH, COD, BOD, turbidity, temperature, chlorides, conductivity and heavy metals. (Taiwo O. et.al.,2018). The dye effluents are high in colour, pH, suspended solids (SS), chemical oxygen demand (COD), biochemical oxygen demand (BOD) (Yaseen and Scholz 2016).

Common Effluent Treatment Plant (CETP) has been set up by Pali Water Pollution Control Treatment and Research Foundation (PWPCTRF) on Mandia Road to minimize the problem of water pollution caused primarily by textile units in Pali, which operates on Biological treatment (Activated sludge) (Sharma.N.et.al.,2013).

2. Material and Methods

Site Description

Pali city is known for its textile dyeing and printing work. The textile dyeing and printing units situated at Pali have been discharging effluents in the river Bandi. Water quality of Bandi River is severely polluted due to textile effluents (Rathore 2011). The current studies, therefore, have been taken up to assess the chemical characteristics of the industrial wastewater effluents in the surrounding area of Pali, and the extent of pollution load in the wastewater discharged in the river Bandi.Pali is the industrial dying and printing hub of Rajasthan state. At present about 800 textile industries are working.

Sampling Sites and Sample Collection –

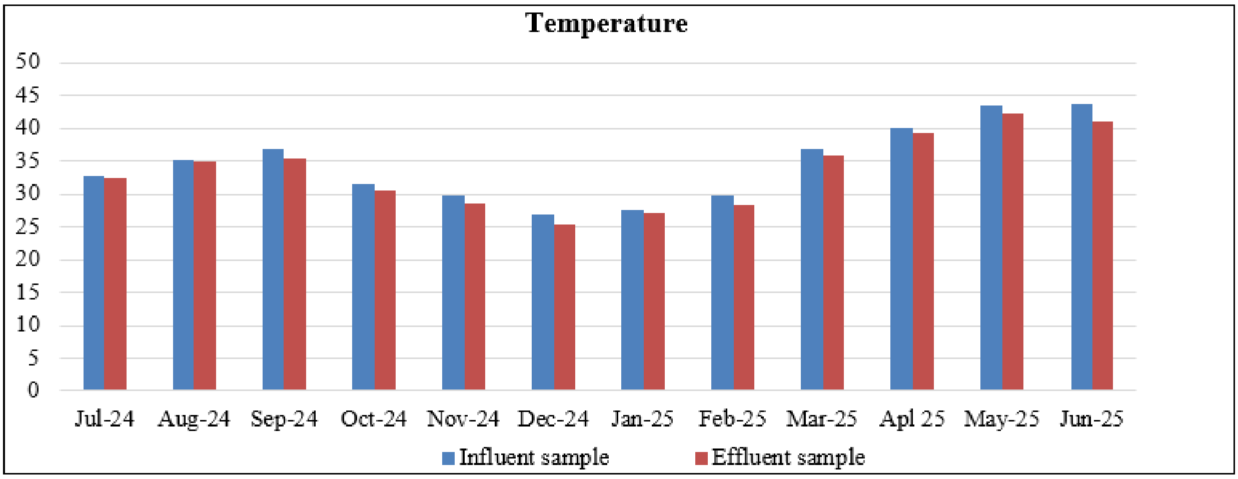
Monthly Water sample were collected from two different sampling sites of Pali industrial area for 12 months. The collected samples were detected for various water quality parameters viz. Water Temperature analyzed by simple thermometer pH, TSS (Total suspended solids), TDS (Total dissolved solids), TS (Total Solids), hardness, Biological Oxygen Demand (BOD), and Chemical Oxygen Demand (COD). For analysis of the water samples, standard methods of Trivedi and Goyal, (1986) and APHA, (2005) were followed for the analysis. The temperature, pH analysis and fixation of dissolved oxygen were done at the site.

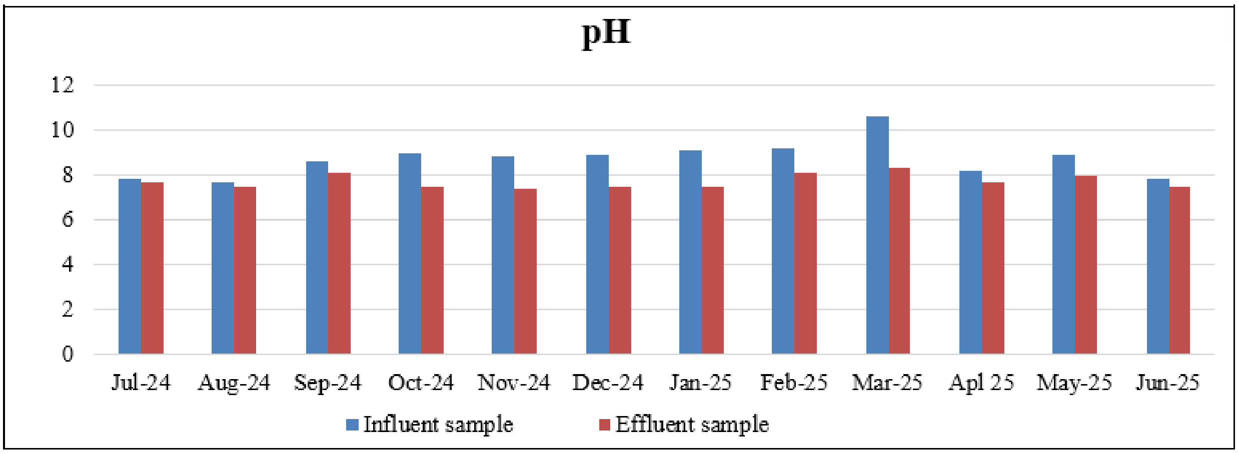
Table 1: Monthly Variations in Physico-chemical Parameters of Influent Samples at Bandi River (July 2024 – June 2025)

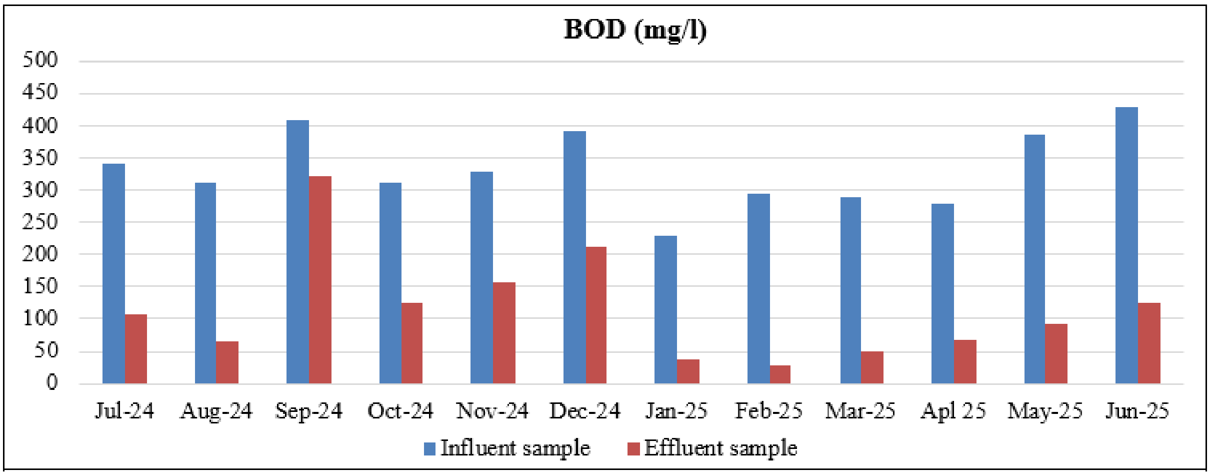
Months	Temp. °C	pH	BOD (mg/l)	Hardness (mg/l)	COD (mg/l)	TDS (mg/l)	TSS (mg/l)	Sulphate (mg/l)	Chloride (mg/l)
Jul-24	32.8	7.8	341	940	2063	7350	546	917	2710
Aug-24	35.2	7.7	312	890	1788	6670	412	1047	2230
Sep-24	36.8	8.6	408	1280	1786	6520	458	1245	2250
Oct-24	31.5	9	312	1070	1474	5240	264	1143	2350
Nov-24	29.8	8.8	328	890	1364	5970	212	1056	2340
Dec-24	26.8	8.9	390	1130	1597	6210	593	926	2490
Jan-25	27.5	9.1	230	1280	1325	7030	980	526	1350
Feb-25	29.7	9.2	295	1220	1459	5620	1348	364	1562
Mar-25	36.8	10.6	290	1350	2636	5140	1044	658	4258
Apl 25	40.1	8.2	280	1080	1692	6020	188	570	3740
May-25	43.5	8.9	386	950	2120	4150	201	1064	2360
Jun-25	43.8	7.8	429	880	2530	6380	830	1264	2320
Maximum value	43.8	10.6	429	1350	2636	7350	1348	1264	4258
Minimum value	26.8	7.7	230	880	1325	4150	188	364	1350
Mean value	34.63	8.7	332.85	1085	1842.5	5985.714	615.14	886.29	2540.571

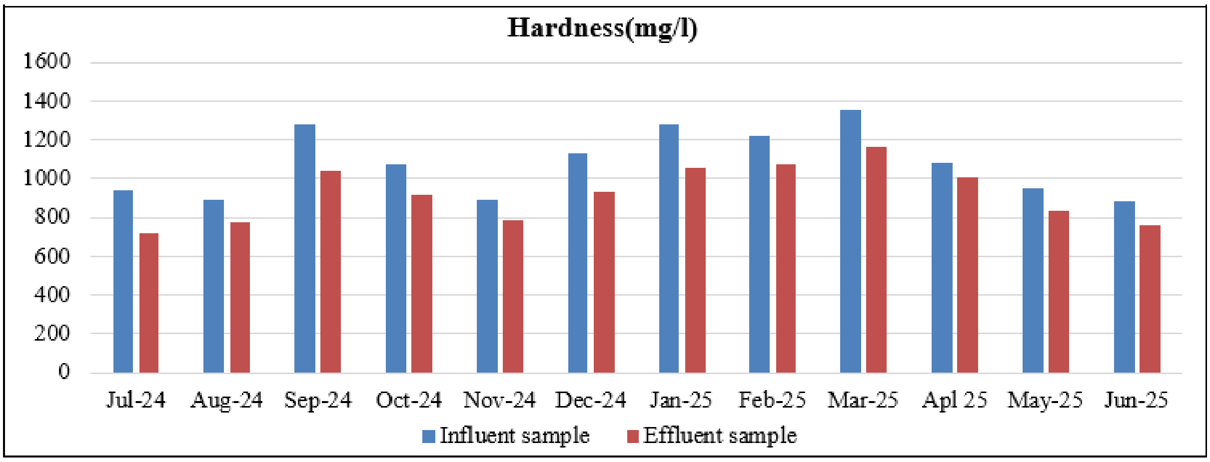
Table 2: Monthly Variations in Physico-chemical Parameters of effluent Samples at Bandi River (July 2024 – June 2025)

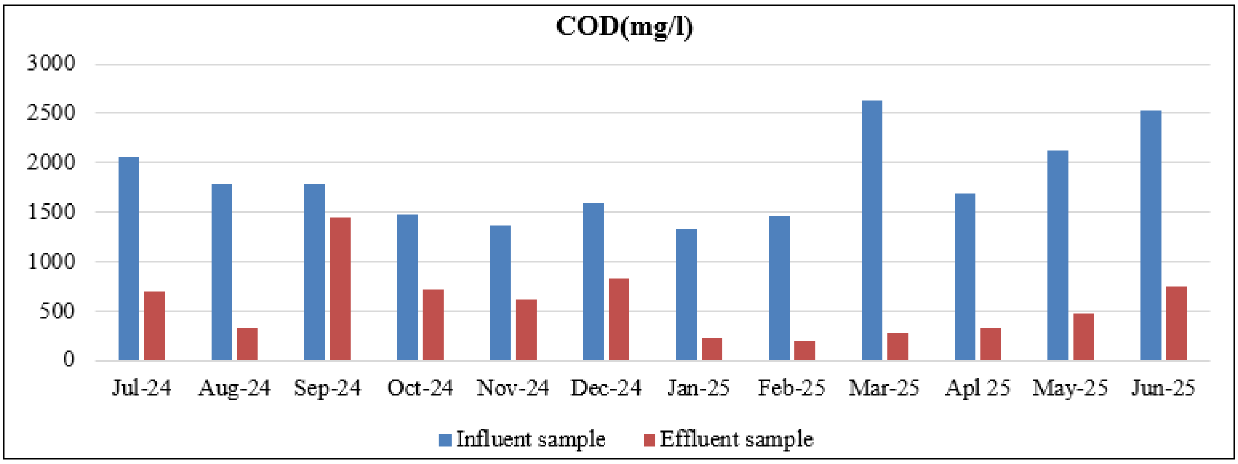
Months	Temp. °C	pH	BOD (mg/l)	Hardness (mg/l)	COD (mg/l)	TDS (mg/l)	TSS (mg/l)	Sulphate (mg/l)	Chloride (mg/l)
Jul-24	32.4	7.7	107	720	706	7840	217	1168	3240
Aug-24	34.8	7.5	64	780	329	7005	46	1152	2590
Sep-24	35.4	8.1	320	1040	1446	6880	258	1045	2710
Oct-24	30.5	7.5	126	915	714	6120	138	1240	2780
Nov-24	28.5	7.4	156	785	616	6456	84	982	2750
Dec-24	25.4	7.5	212	930	837	7230	68	847	3190
Jan-25	27.1	7.5	38	1055	235	8010	15	1066	2760
Feb-25	28.3	8.1	27	1070	193	5940	44	490	1193
Mar-25	35.8	8.3	51	1160	273	5800	38	648	2072
Apl 25	39.2	7.7	68	1010	320	6995	32	941	3520
May-25	42.2	8	93	835	466	6030	56	1053	3020
Jun-25	41	7.5	126	760	751	7750	590	1232	3230
Maximum value	42.2	8.3	320	1160	1446	8010	590	1240	3520
Minimum value	25.4	7.4	27	720	193	5800	15	490	1193
Mean value	33.44	7.7	123.92	924.29	608.93	6847.57	156.5	971	2697.71

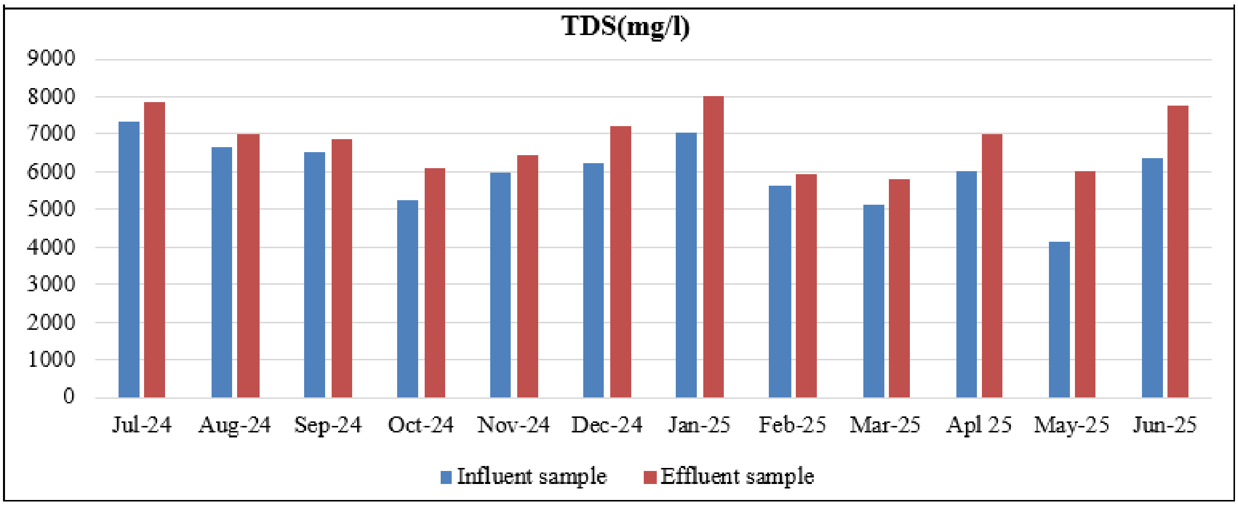

Temperature
50
45
40
35
30
25
20
15
10
5
0
Jul-24
Aug-24
Sep-24
Oct-24
Nov-24
Dec-24
Jan-25
Feb-25
Mar-25
Apl 25
May-25
Jun-25
Influent sample
Effluent sample

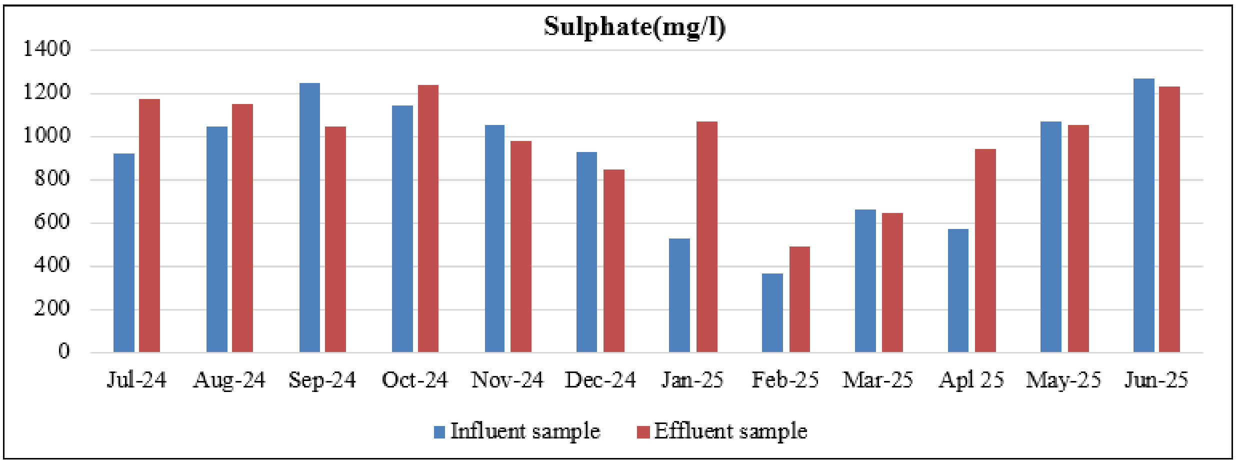

pH
12
10
8
6
4
2
0
Jul-24
Aug-24
Sep-24
Oct-24
Nov-24
Dec-24
Jan-25
Feb-25
Mar-25
Apl 25
May-25
Jun-25
Influent sample
Effluent sample

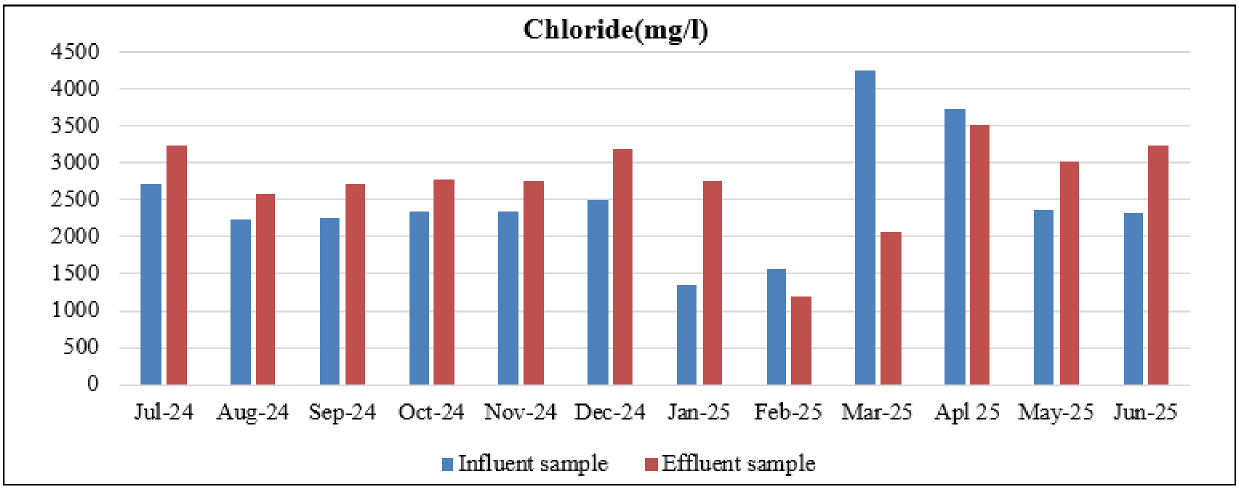

BOD (mg/l)
500
450
400
350
300
250
200
150
100
50
0
Jul-24
Aug-24
Sep-24
Oct-24
Nov-24
Dec-24
Jan-25
Feb-25
Mar-25
Apl 25
May-25
Jun-25
Influent sample
Effluent sample


Hardness(mg/l)
1600
1400
1200
1000
800
600
400
200
0
Jul-24
Aug-24
Sep-24
Oct-24
Nov-24
Dec-24
Jan-25
Feb-25
Mar-25
Apl 25
May-25
Jun-25
Influent sample
Effluent sample


COD(mg/l)
3000
2500
2000
1500
1000
500
0
Jul-24
Aug-24
Sep-24
Oct-24
Nov-24
Dec-24
Jan-25
Feb-25
Mar-25
Apl 25
May-25
Jun-25
Influent sample
Effluent sample


TDS(mg/l)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Jul-24
Aug-24
Sep-24
Oct-24
Nov-24
Dec-24
Jan-25
Feb-25
Mar-25
Apl 25
May-25
Jun-25
Influent sample
Effluent sample


Sulphate(mg/l)
1400
1200
1000
800
600
400
200
0
Jul-24
Aug-24
Sep-24
Oct-24
Nov-24
Dec-24
Jan-25
Feb-25
Mar-25
Apl 25
May-25
Jun-25
Influent sample
Effluent sample



3. Results and Discussion

In sampling station, the maximum temperature of influent sample (43.8^{0}C) was observed in the month of June 2025 and effluent sample (42.2^{0}C) was observed in the month of May 2025 and the minimum temperature of influent sample (26.8^{0}C) was found in month of December 2024 and effluent sample (25.4^{0}C) was observed in the month of December 2024 (Table 1, Fig.1).

The maximum pH of influent sample (10.6) was observed in the month of March 2025 and effluent sample (7.7) was observed in the month of August 2025 and the minimum pH of influent sample (8.3) was found in month of March 25 and effluent sample (7.4) was observed in the month of November 2024 (Table 2, Fig.2).

The maximum BOD of influent sample (429 mg/l) was observed in the month of July 2025 and effluent sample (320 mg/l) was observed in the month of September 2024 and the minimum BOD of influent sample (230 mg/l) was found in month of January 2025 and effluent sample (27mg/l) was observed in the month of February 2025. (Table 3, Fig.3).

The maximum Hardness of influent sample (1350 mg/l) was observed in the month of March 2025 and effluent sample (1160 mg/l) was observed in the month of March 2025 and the minimum Hardness of influent sample (880 mg/l) was found in month of June 2025 and effluent sample (720 mg/l) was observed in the month of July 2024 (Table 4, Fig.4).

The maximum COD of influent sample (2636 mg/l) was observed in the month of March 2025 and effluent sample (1446 mg/l) was observed in the month of September 2024 and the minimum COD of influent sample (1325mg/l) was found in month of January 2025 and effluent sample (193 mg/l) was observed in the month of February 2025 (Table 5, Fig.5).

The maximum Total dissolved solid of influent sample (7350 mg/l) was observed in the month of July 2024 and effluent sample (8010 mg/l) was observed in the month of January 2025 and the minimum Total dissolved solid of influent sample (4150 mg/l) was found in month of May 2025 and effluent sample (5800 mg/l) was observed in the month of March 2025 (Table 6, Fig.6).

The maximum Total suspended solid of influent sample (1348 mg/l) was observed in the month of February 2025 and effluent sample (590 mg/l) was observed in the month of June 2025 and the minimum Total suspended solid of influent sample (188 mg/l) was found in month of April 25 and effluent sample (15 mg/l) was observed in the month of January 2025 (Table 7, Fig.7).

The maximum Sulphate ion concentration of influent sample (1264 mg/l) was reported in the month of June 2025 and effluent sample (1240 mg/l) was observed in the month of October 2024 and the minimum Sulphate ion concentration of influent sample (364 mg/l) was found in month of February 2025 and effluent sample (490 mg/l) was observed in the month of February 2025 (Table 8, Fig.8).

The maximum chloride ion concentration of influent sample (4258 mg/l) was reported in the month of March 2025 and effluent sample (3520 mg/l) was observed in the month of April 2025 and the minimum chloride ion concentration of influent sample (1350 mg/l) was found in month of January 2025 and effluent sample (1193 mg/l) was observed in the month of February 2025 (Table 9, Fig.9).

4. Conclusion

The huge quantities of wastes and sludge discharged from industries might be responsible for the enrichment of all studied physico-chemical parameters at discharging point by Tabassum *et al.,* (2015). Due to increasing the heavy load of such nutrient in water body their biological oxygen demand also more Dabhade and Tandale (2016) Rathore (2012) studied the wastewater from industries had a deleterious impact on the water quality of Bandi river.

This study has shown that textile mills discharges effluent with high degree of COD and BOD values which are not in compliance with standards. Huge amount of water and chemicals are used in different processes which are discharged as waste water that are high in COD, BOD, TDS and toxic chemicals. Textile effluent is the most signifacant parameter for water pollution in Bandi River, Pali. It is observed by the study that the pH of River water is more than the permissible limit while most of the parameter like BOD, Total Hardness are found much higher concentration.

Thus, it can be concluded that soils are quite alkaline in nature due to high ph. Hence we predicted that Bandi river water is unsafe for drinking. This study concluded that textile effluents are highly toxic in nature and effects on these River water parameters. In spite of the installation of CETP, the Bandi river still has enormous soil pollution adversely affecting the soil fertility.

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