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(Research Article)

An assessment of seasonal variation in physicochemical parameters of secondary treated wastewater used in Sri Ganganagar and Hanumangarh, Rajasthan

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Abstract

Water is one of the five essential elements of life; Earth (Prithvi), Water (Jal), Fire (Agni), Air (Vayu) and Space (Akash). Quality and quantity of these fundamental elements affects health, ecosystems and economics. Water scarcity and contamination are becoming a big challenge to life support on this blue planet. The present study is aimed to study the seasonal variation in physicochemical parameters like pH, electrical conductivity, COD, BOD, TH, TA and TDS, various cations and anions of secondary treated wastewater of Sri Ganganagar and Hanumangarh, Rajasthan. Various parameters showed distinct seasonal variation with higher value for most of the parameters in pre-monsoon season. Higher BOD values may cause adverse effect on aquatic biota. The study showed a need for regular monitoring of the treatment plants.

Keywords: Secondary Treated Wastewater; Seasonal Variation; Sewage Treatment; Physicochemical Parameters

1. Introduction

Diverse uses of water like drinking, cooking, cleaning, washing, irrigation, commercial and industrial activities etc. make it essential and most valuable natural resource for sustaining life on this planet. These beneficial uses of water largely depend on water quality in terms of various physicochemical and biological parameters. Water quality in turn decides life support and sustainability of an ecosystem [1]. Surface water quality is basically governed by natural as well as anthropogenic processes like rainfall, erosion, agricultural, commercial and industrial activities [2]. Exponential population growth, change in lifestyle, limitless industrialization and urbanization has resulted in tremendous sewage generation [3]. Sewage water contains a lot of contaminants depending on its source of generation. Various chemical and biological pollutants make water unfit for drinking and other uses. Improper sewage disposal is contaminating water bodies to an alarming extent in developing as well as developed countries. To identify and keep a check on pollution status of water bodies, water quality monitoring is a key tool. The sewage characteristics of treatment plants should be regularly monitored to know the pollutant levels upon the various time scales [4]. If wastewater treatment schemes are properly managed, have high potential to reduce waste production and improve environmental health [5].

2. Literature review

Kushwaha et.al. showed distinct seasonal variation in physicochemical parameters of the influent and effluent water from a Sewage Treatment Plant in Bhopal, India [6]. Olayinka and Anthony evaluated the final effluents of two wastewater treatment plants (WWTPs) in the Eastern Cape Province of South Africa for their physicochemical and microbiological qualities over a period of 12 months [7]. They concluded that these WWTPs are important point sources of pollution in surface water with potential public health and ecological risks. Chebor et.al. determined the seasonal differences of wastewater treatment that employs screens, trickling filters and oxidation ponds. Analysis of water

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samples from four different points was carried out during the dry and wet seasons of the year 2013 and recorded lower figures for most of the parameters during wet season [8]. Mahgouba et.al. conducted studies on treatment operations of 17 wastewater treatment plants (WTPs) in cold and hot climate over a one-year period. The study was carried out to evaluate the quality of wastewater in drainages that discharge from these WTPs distributed in the province of Al-Sharqiyah, in Egypt [9]. The results indicated that the treatment plants had a significant role in the control of pollution load from microbial, organic and inorganic pollution at the province of Al-Sharqiyah. Upstream development and inadequate wastewater treatment facilities have an important negative impact on water quality in the downstream sections of the major rivers [10].

Most of the industries of Sri Ganganagar and Hanumangarh area do not have effluent treatment facilities so wastewater from such industries and other commercial activities get mixed with sewage but STPs are not designed for it. So, the STPs may not meet the norms prescribed by pollution control boards. Therefore, an attempt has been made to know the physicochemical properties of treated waste water. It is very important to analyze the physicochemical parameters of such water and to assess the applicability of treated waste water for various purposes.

3. Materials and methodology

To evaluate the impact of various physicochemical parameters on treated water quality of Sriganganagar and Hanumangarh city, water samples were collected from four different selected sites in the four seasons (pre-monsoon, post-monsoon, winter and spring periods) throughout the year from February, 2020 to January, 2021. Composite sampling on every site was done fortnightly in morning and evening and then analysed using methods [11] as per Table 1. For the present study, four sites equipped with ETP or STP located in Sri Ganganagar and Hanumangarh district headquarters were selected –

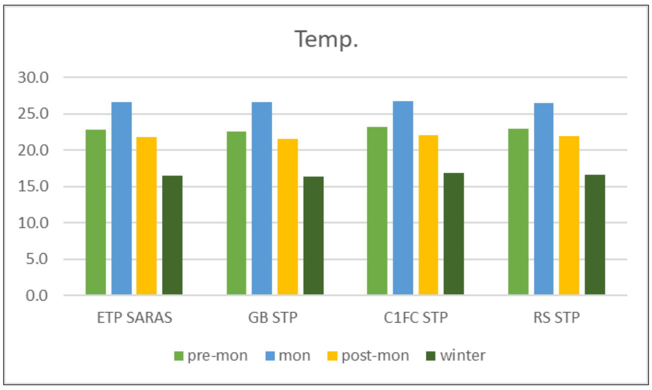
- ETP SARAS, Hanumangarh
- Ghaghar Bridge (GB) STP, Hanumangarh
- Chak 1 F Chhoti (C1FC) STP, Sri Ganganagar.
- Ridhi-Sidhi (RS) STP, Sri Ganganagar.

Table 1 Standard methods adopted for analysis

S. No.	Parameter	Method	Page No.
1	Temperature	Lab & field method	2550 B2-74
2	pH	Electrometric method	4500-H+ B4-95
3	Electrical Conductivity (EC)	Laboratory method	2510 B2-58
4	Chemical Oxygen Demand (COD)	Titrimetric method	5220 C5-20
5	Biochemical Oxygen Demand (BOD)	5-Day BOD test	5210 B5-6
6	Total Hardness (TH)	EDTA Titrimetric method	2340 C2-48
7	Total Alkalinity (TA)	Titration method	2320 B2-36
8	Total Dissolved Solids (TDS)	Dried at 180oC	2540 C2-69
9	Sodium (Na^+)	Flame photometric method	3500-Na, B3-69
10	Potassium (K^+)	Flame photometric method	3500-K, B3-89
11	Calcium (Ca^{+2})	EDTA Titrimetric method	3500-Ca, B3-69
12	Magnesium (Mg^{+2})	Calculation method	3500-Mg, B3-86
13	Nitrate (NO_3^-)	UV-Spectrophotometric method	4500- NO3- B4-127
14	Sulphate (SO_4^{-2})	UV-Spectrophotometric method	4500- SO4-2 B4-127
15	Chloride (Cl^-)	Argentometric method	4500-Cl-, B4-75
16	Fluoride (F^-)	Ion-Selective Electrode method	4500-F-, B4-89

Table 2 Seasonal Variation of Physico-Chemical Parameters of study sites.

Para Meter	**SARAS ETP, Hanumangarh**				**GB STP, Hanumangarh**				**C1FC STP, SriGanganagar**				**RS STP, SriGanganagar**			
	Pre Mon	Mon	Post Mon	Winter	Pre Mon	Mon	Post Mon	Winter	Pre Mon	Mon	Post Mon	Winter	Pre Mon	Mon	Post Mon	Winter
Temp.	22.8	26.7	21.8	16.5	22.6	26.7	21.7	16.4	23.2	26.8	22.1	16.8	23.1	26.6	21.9	16.7
pH	8.6	8.3	8.3	8.3	7.5	7.2	7.4	7.2	7.8	7.2	7.5	7.3	7.6	7.2	7.4	7.3
EC	782.7	751.7	714.7	738.7	1288.3	1021.7	813.3	1097.3	1905.0	1240.5	979.3	1477.3	1026.7	925.0	853.0	811.8
COD	77.7	59.4	48.4	51.0	128.3	86.0	121.3	126.5	167.7	113.2	154.8	160.0	164.7	138.7	143.8	139.2
BOD	40.3	29.8	25.5	26.7	53.3	35.3	54.5	51.3	66.0	41.3	65.3	61.2	63.8	48.3	50.4	50.4
TH	101.7	97.3	97.2	90.8	306.3	300.2	301.2	286.2	259.3	175.3	209.5	198.0	216.0	165.2	189.7	190.7
TA	141.3	131.0	127.2	127.8	275.7	271.8	278.8	262.2	321.3	409.8	361.7	321.5	247.3	174.2	190.2	193.8
TDS	294.0	307.2	265.7	235.0	721.3	656.8	546.5	670.8	725.0	484.3	604.8	653.0	557.7	544.8	534.0	507.0
Na^+	75.3	66.7	71.3	74.0	106.0	85.5	87.7	92.8	90.0	74.3	86.8	90.3	97.3	78.5	87.3	89.7
K^+	6.9	6.5	7.0	7.4	9.9	10.2	10.2	9.2	9.8	8.6	8.1	8.5	9.1	8.8	9.1	8.7
Ca^{+2}	21.3	20.4	21.1	19.0	59.2	63.4	56.6	53.5	44.9	46.1	40.6	40.0	43.9	35.3	39.5	39.5
Mg^{+2}	11.8	11.3	10.8	10.5	38.3	34.4	38.8	36.9	21.1	22.4	18.2	16.9	25.8	18.6	22.1	22.4
NO_3^-	1.5	1.5	1.3	1.0	5.9	5.5	6.0	5.2	10.3	8.5	9.2	7.8	5.9	4.4	3.4	3.8
SO_4^{-2}	6.2	6.3	6.2	5.5	46.7	56.5	35.8	42.0	90.7	75.3	65.7	84.3	65.3	59.2	52.8	54.7
Cl^-	46.0	43.0	44.0	42.7	86.7	74.0	59.5	71.7	101.7	76.2	66.8	90.7	76.3	68.2	72.0	75.2
F^-	0.13	0.15	0.16	0.15	0.38	0.35	0.30	0.33	0.44	0.41	0.35	0.39	0.32	0.31	0.29	0.31


Temp.
30.0
25.0
20.0
15.0
10.0
5.0
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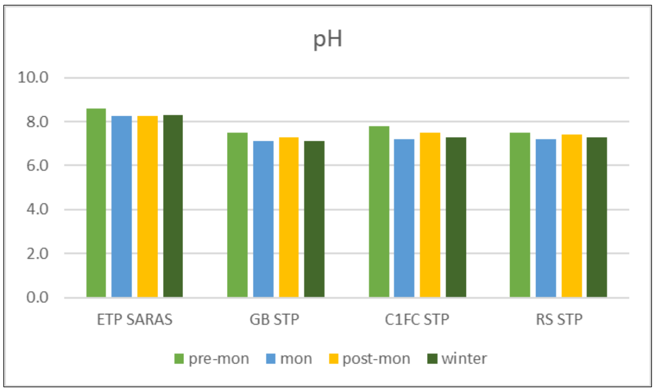
ETP SARAS
GB STP
C1FC STP
RS STP
pre-mon
mon
post-mon
winter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ETP SARAS
GB STP
C1FC STP
RS STP
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mon
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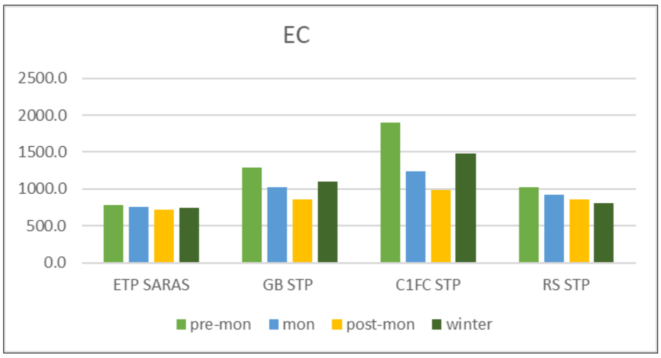
winter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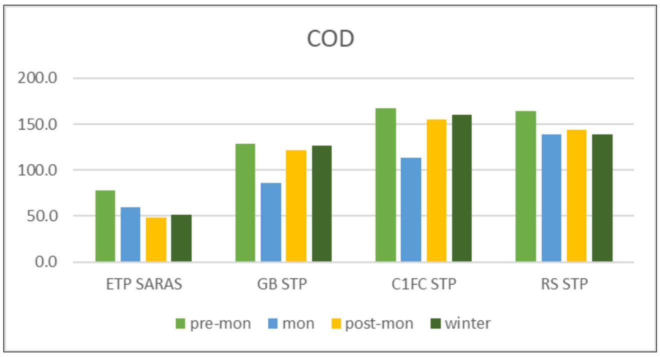
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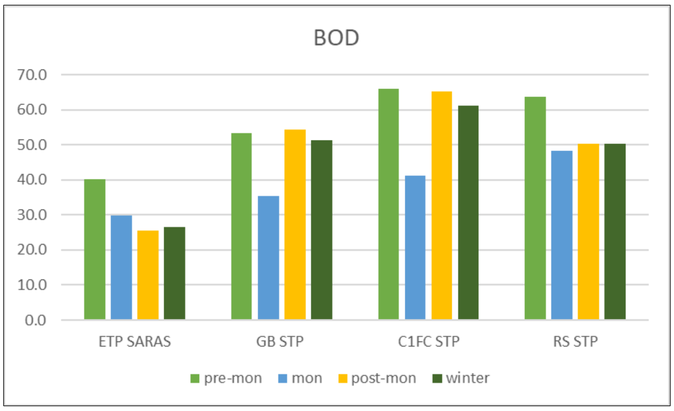
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RS STP
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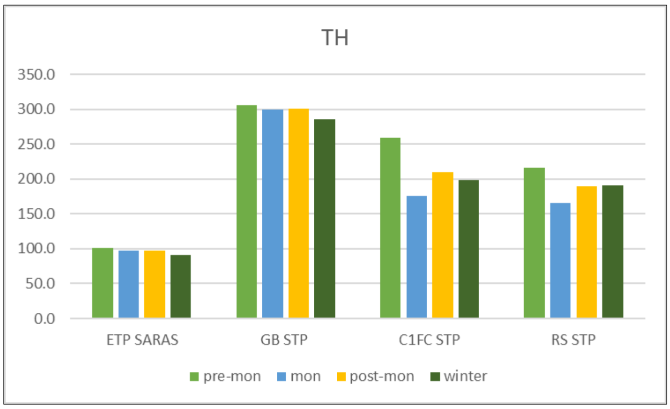
TH
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200.0
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ETP SARAS
GB STP
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RS STP
pre-mon
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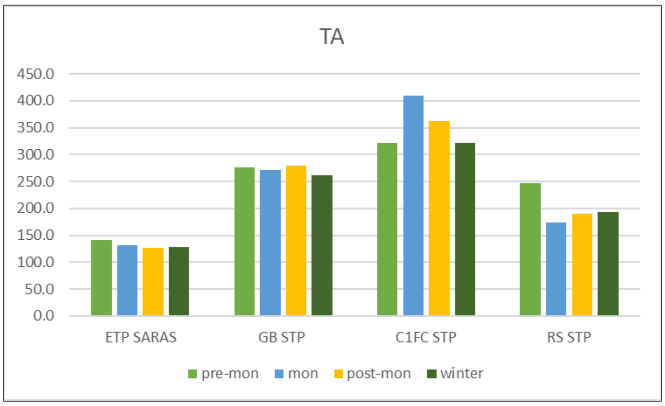
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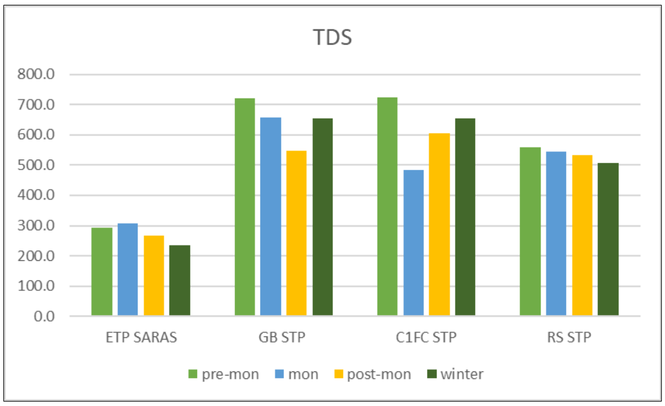
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ETP SARAS
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Figure 1 Seasonal Variation of Physico-Chemical Parameters of Study Sites

4. Results and discussion

The observed values of physical parameters in treated wastewater of study sites for different seasons are shown in Table No 2. Seasonal trends were observed twice monthly for the study period. pH value for all the STP's under study is higher in pre-monsoon season than the post monsoon because of discharges like soaps and detergents added to the sewage gets concentrated in the dry season. These changes are contributed to changes in atmospheric temperature, microbial decomposition due to less efficient treatment process. [12]

Conductivity of water varies directly with the temperature and is proportional to its dissolved inorganic solids. It is an important tool to check the purity of water. The conductivity measurement gives rapid and practical estimate of the variations in the dissolved mineral content of water. EC was significantly higher during pre-monsoon sampling period in all the four treatment plants as water gets concentrated due to high rate of evaporation. Rainfall in monsoon dilutes the water and EC values get lowered. One of the reasons of conductivity is the high concentration of cations such as sodium, calcium and magnesium whereas chloride, phosphate and nitrate as anions [13]. In the study area, average EC values of all water samples were found within the permissible limits of BIS standards (2250 $\mu S\ cm^{-1}$). However, according to Brayan et.al. [14] classification of irrigation water, most of the samples of GB (95%), C1FC (100%) and RS (95%) fall under medium hazard category and such water use requires some management. EC of 67% samples of SARAS samples is with low hazard and can be used with moderate leaching.

COD value for all the four STP's study is higher in pre-monsoon season due to the presence of organics and inorganics in sewage water and its disintegration that consumes more oxygen than the biological degradation. The seasonal trend in BOD value is showing a rise in pre-monsoon season for SARAS, C1FC and RS while it is slightly higher in post-monsoon for GB STP. The higher values of BOD are attained by the higher biological activity and the availability of much waste for degradation [15], which might be the result of untreated sewage, solid and industrial waste discharge [16]. Higher BOD is a reflection of microbial oxygen demand leading to depletion of DO which may cause hypoxia conditions with consequent adverse effects on aquatic biota [17].

TH was significantly higher during pre-monsoon sampling period in all the four treatment plants as water gets concentrated due to high rate of evaporation. Rainfall in monsoon dilutes the water and TH values get lowered. However, in the study area TH values of 89.3% water samples were found within the permissible limits of BIS standard (300mg/l).

Alkalinity is a measure of how much acid can be added to a liquid without causing a large change in pH. TA did not show much seasonal variation for SARAS and GB STP whereas TA was higher in pre-monsoon for RS STP and in monsoon season for C1FC STP. However, GB (271.6 mg/l) and C1FC (358.1mg/l) STP recorded higher average TA values than acceptable limits of 200 mg/l (IS-10500) but lower than EPA (400) [18]. Higher TA than standard values may be attributed to the high amounts of anionic surfactants and alkalis associated with commonly used domestic detergents which are carried by domestic effluents into the sewage treatment plants [19].

TDS was higher in pre-monsoon for C1FC, GB and RS STP and in monsoon season for SARAS ETP. Total Dissolved Solids (TDS) values are higher in pre monsoon as water gets concentrated due to high temperature. Rainfall in monsoon dilutes the water and Total Dissolved Solids (TDS) values get lowered.

Na^+ and F^- were significantly higher during pre-monsoon sampling period in all the four treatment plants (Table no. 2). All other chemical parameters Ca^{2+}, Mg^{2+}, K^+, Cl^-, SO_4^{2-}, and NO_3^- show no seasonal trend. Most of the matter in water samples is in dissolved form and consist mainly of inorganic salts such as Ca^{2+}, Mg^{2+}, Na^+, K^+, Cl^-, SO_4^{2-}, CO_3^{2-}, HCO_3^- and small amounts of organic matter, dissolved gases, which contribute to TDS.

5. Conclusion

The results of studies on various physio-chemical parameters of secondary treated wastewater revealed that the working treatment plants in study area exhibit effluent qualities that in general meet acceptable standards. Seasonal trend for most of the physical parameters are showing higher value in pre-monsoon as water gets concentrated due to higher evaporation rate. Except Na^+ and F^- all other chemical parameters Ca^{2+}, Mg^{2+}, K^+, Cl^-, SO_4^{2-}, and NO_3^- show no seasonal trend. The study showed a need for regular monitoring of the treatment plants.

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