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Evaluation of Seasonal Variation of Physico-Chemical Parameters of Hospital Wastewater Treatment Plant

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Abstract: Water defilement is one of the alarming problems in our society due continuous sewage / wastewater disposal without adequate treatment. Physicochemical parameters of water are one criterion to determine the level of contamination of water. In this study, Seasonal variations of physicochemical parameters of a Teaching Hospital wastewater treatment plant in Zaria were evaluated to ascertain the pollution load and determined the significant difference between Influent and Effluent contaminant concentration. Both Influent and Effluent samples were analyzed during dry and wet seasons using standard instrumental techniques. Descriptive statistics was used for data analysis to evaluate the significant differences between the means of the samples. The parameters assessed were pH, Temperature, EC, TDS, Cl, PO_4^-, DO, BOD, COD, Na, K, NO_3, TSS, NH_3 and SO_4. The result obtained with respect to PO_4^- between dry and wet seasons were (48.41 ± 6.96a dry season) / (28.72 ± 5.2b wet season), with significance difference at P>0.05. Similarly, HCO_3^-(6.04 ± 0.19a dry season) / (3.68 ± 0.96b wet season) and BOD (111.26 ± 3.36b dry season) / (245.48 ± 13.59a wet season) all from Influent. While results obtained from the effluent with significant difference in dry and wet seasons were BOD (144.36 ± 6.35b dry season) / (258.26 ± 15.17a wet season) at P > 0.05. Generally, pH (7.52 ± 0.45 / 7.58 ± 0.38) Temperature (22.50 ± 0.76 / 25.17 ± 0.31), EC (1020.17 ± 51.40 / 914.57 ± 9.48), NO_3 (4.12 ± 0.96 / 3.74 ± 1.5), TDS (511.33 ± 20.25 / 508.23 ± 36.90), Cl (108.62 ± 3.47 / 215.87 ± 6.14) and SO_4 (8.17 ± 0.14 / 12.54 ± 40.04), were within the acceptable threshold of FAO, NESREA and WHO guidelines. However parameters such as PO_4^- (61.80 ± 9.25 / 53.63 ± 6.14), BOD (144.36 ± 6.35 / 258.26 ± 15.17), DO (16.13 ± 1.46), COD (409.917 ± 86.72 / 565.83 ± 79.25) TSS (16.66 ± 8.027 / 25.36 ± 6.51), and NH_3^- (0.99 ± 0.14 / 0.91 ± 0.40) were found to be above the acceptable threshold of FAO, NESREA and WHO guidelines and standards. The study concludes that the treatment plant does not effectively treat the wastewater and could therefore, lead to possible contamination to the downstream water which can pose health issues to humans and crops when used for irrigation.

Keywords: Wastewater, Influent, Effluent, Seasonal Variation, Pollution

1. Introduction

Water is a basic need of life since the existence of living things. Physicochemical monitoring of water quality is important for public health and quality of life and environment [1]. Water pollution is the leading worldwide cause of death and diseases accounting for the deaths of 1.8 million people in 2015 and is a major global problem, therefore requiring ongoing evaluation and revision of water resource policy at all levels (International down to individual aquifers and wells [2].

The quality of water is of vital concern to mankind because it directly linked with human health. Water is fundamental to life on our planet, but this precious resource

is increasingly in demand and under threat. The earth's surface is made up of 70% water including rivers, beels, lakes, streams, seas, oceans, groundwater and all these forms are very important in life cycle [3]. In recent times, the menace of water borne diseases and epidemics still looms large on the horizons of developed and developing countries and polluted water is the culprit in all such cases [4].

According to [5], the quality of water globally has been affected negatively because of the overgrowth of the population, human activities, fast industrialization, unskilled utilization of natural water resources and unplanned urbanization.

The chemical, physical, and biological characteristics of water determine water quality, usually in respect to its suitability for a designated use. The quality of water is primarily governed by the extent and composition of dissolved solids present in it. The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. It is necessary to know details about different physicochemical parameters such as color, taste, odor, TDS, pH, Hardness, alkalinity, chlorides, fluoride, sulphate, Iron, Turbidity and nitrate used for testing of water quality [6].

Many studies stated that the use of polluted water for irrigation purposes has impact with negative effect on agricultural sectors due to the changes in physicochemical properties [7]. Excessive pollutant discharge into natural water bodies gives rise to the elevated level of Total Dissolve Solid (TDS), nutrients, organic substances and other contaminants, resulting in alteration of aquatic organism and eutrophication [8].

Hospital wastewater contains harmful pollutants generated from all activities of the hospital as medical and non-medical activities. The discharge of wastewater or effluents directly into the environment by hospitals without treatment has been a common practice especially in developing countries like Nigeria [9].

The availability of safe and sufficient water supplies is inextricably linked to how wastewater is managed. Increased amounts of untreated sewage, combined with agricultural runoff and industrial discharge, have degraded water quality and contaminated water resources around the world. Far from being something to discard or ignore, wastewater will play a major role in meeting the growing water demand in rapidly expanding cities, enhancing energy production and industrial development and supporting sustainable agriculture.

Pollution of water is measured by assessing the physiochemical parameters of water. Analysis of physicochemical parameters is of paramount importance to assess the quality of water before utilizing for irrigation, drinking, fisheries and industrial purpose and in understanding the complex interaction and processes between climatic and biological processes in the water [10]. The physicochemical parameters of water and the dependence of all life processes of these factors make it desirable to take as an environment. It is therefore necessary that the quality of water should be checked at regular interval, because due to use of contaminated water, human population suffers from various water borne diseases [11].

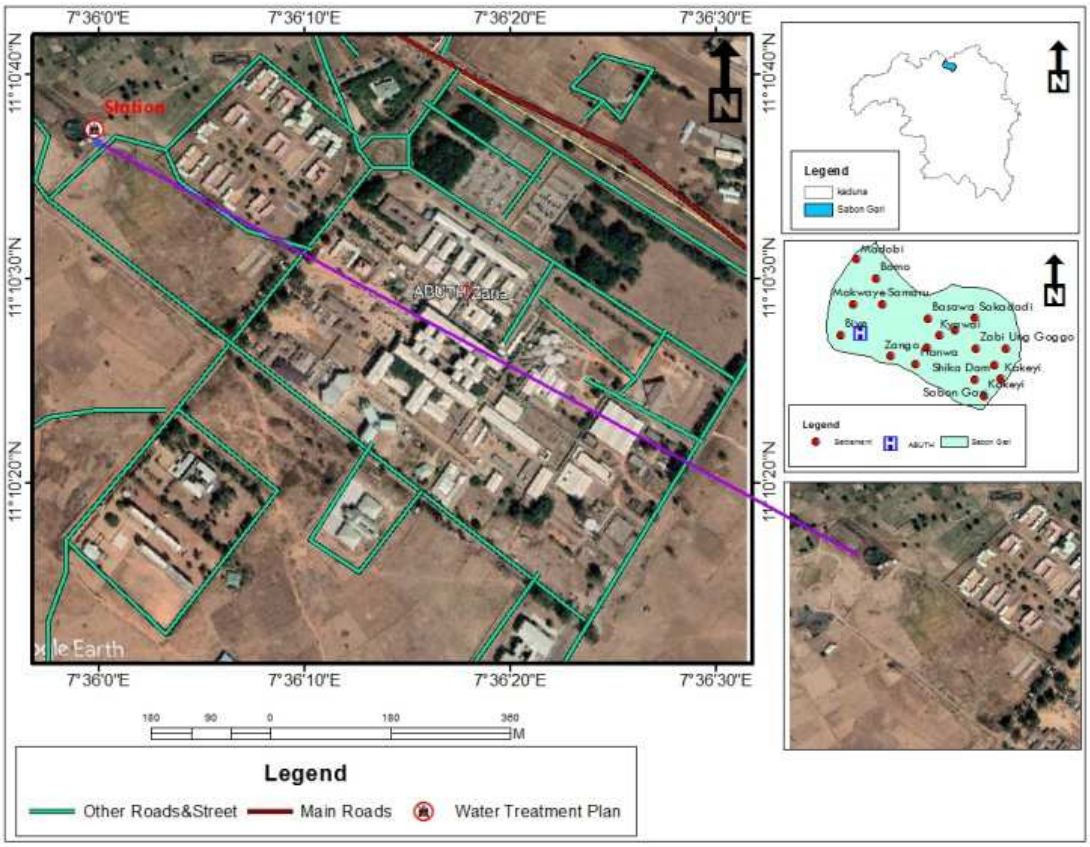

Figure 1. *Map of the study area showing sampling location.*

2. Materials and Methods

2.1. Sampling of Wastewater

Samples were collected from a University Teaching Hospital, Wastewater Treatment plant; in both Influent and Effluent discharge points.

One-liter polyethene bottles was properly washed with mild detergent and then leached with 1:1 HCl overnight. At the Sampling sites, the containers were rinsed several times with deionized water and rinsed three times with the wastewater before the samples was collected.

2.2. Physicochemical Parameters Analysis

pH, Temperature and Electrical conductivity were measured with pH meter (model Jenway 3310), thermometer and conductivity meter (Hach model C0150) on site by immersion of the calibrated instruments dip in the water sample until readings were stable and recorded.

Other parameters were taken and analyzed immediately in the laboratory using standard methods for the examination of water and wastewater (23rd Edition). Descriptive statistics was used for data analysis to evaluate the significant differences between the means of the samples.

3. Result and Discussion

The physicochemical parameters investigated in the study from both Influent and Effluent are shown in tables 1 and 2 below:

Table 1 shows the seasonal variation of the physicochemical parameters from the Influent of the wastewater. There was significance difference at P>0.05 (95% confidence) between dry and wet seasons of PO_4^- (48.41 ± 6.96a dry season)/(28.72 ± 5.2b wet season), HCO_3^-(6.04 ± 0.19a dry season)/(3.68 ± 0.96b wet season) and BOD (111.26 ± 3.36b dry season)/(245.48 ± 13.59a) from Influent. There was significance difference at P>0.05 between dry and wet season of BOD (144.36 ± 6.35b dry season)/ (258.26 ± 15.17a wet season) only from Effluent. BOD in Influent is lower than effluent signifying inadequate removal. All other parameters were insignificantly different in dry and wet season. The water temperature fluctuated between 21°C -26°C during the study which falls within the adopted range for tropical water bodies and the pH Values were within the alkaline state during the Sampling period and fluctuated between 6.5 -8.29. This could be due to patterns of water use and rainfall as stated in the previous findings of [12] in the study of Seasonal Variation in the physicochemical parameters of Lake Ribadu in Adamawa State.

In both dry and wet season EC, PO_4^-, DO, BOD, COD and K were found to be high above permissible limit standard by WHO, NESREA and FAO, While pH TDS and Cl are within limit standard. This result corresponds with the findings of [13] in the comparative study of physico chemical parameters of wastewater discharged at Beaches in Dakar Coast, where EC and PO_4^- were high above standard limit. Also relate to the findings of [14] in the study of "Seasonal variation of physicochemical and Nutrient water quality of River Tano in Ghana where EC and PO_4^- exceed the permissible limit. BOD and COD are both a function of DO and are inversely proportional.

A similar study of [15] on the "water quality and physicochemical parameters of Outgoing waters in a pharmaceutical plant and stated that similar parameters in this study were high above permissible limit all through the seasonal study period of 5 months except BOD. This is due to the local anthropogenic activities and Agricultural run-off within the environment.

Table 1. *Seasonal Variation of the Physicochemical Parameters Determined In Influent.*

PARAMETERS	DRY	WET	P – Value	WHO	NESREA mg/l	FAO
Temp	24.50 ± 0.34[a]	25.00 ± 0.26[a]	0.270	Ambient	Ambient	Ambient
pH	7.78 ± 0.29[a]	7.80 ± 0.25[a]	0.957	6.5-8.5	6.5-8.5	6.5-9
EC	1022.67 ± 66.014[a]	943.67 ± 6.88[a]	0.261	250	-	750
TDS	519.33 ± 33.36[a]	509.83 ± 3.82a	0.783	1000	-	500
Cl	146.93 ± 10.29[a]	104.98 ± 21.89[a]	0.114	250	350	100
PO_4	48.41 ± 6.96a	28.72 ± 5.24b	0.047	3.5	3.5	6.0
HCO_3	6.04 ± 0.19a	3.68 ± 0.96b	0.038	300	200	300
DO	17.03 ± 0.60a	17.46 ± 0.84a	0.684	14	4.0	-
BOD	111.26 ± 3.36b	245.48 ± 13.59a	0.000	30	6.0	30
COD	492.78 ± 79.51a	414.4 ± 44.27a	0.409	75	3.0	200
Na	81.500 ± 7.16a	76.80 ± 6.52a	0.954	200	120	200
K	37.00 ± 2.065a	35.63 ± 3.42a	0.739	12	50	12
NO_3-N	3.70 ± 0.53a	2.96 ± 1.37a	0.624	10	40	20
N	0.87 ± 0.14a	0.85 ± 0.29a	0.968	10	-	30
TSS	11.83 ± 4.01a	13.00 ± 3.98a	0.840	-	0.75	25
NH_3-N	1.06 ± 0.24a	1.11 ± 0.42a	0.917	0.03	-	2.0
SO_4	8.82 ± 2.36a	16.79 ± 8.23a	0.374	150	500	200

Means with the same superscript across the rows are not significantly different at p > 0.05.

Table 2 shows the concentration of physicochemical parameters in Effluent of the wastewater with significance variation between Temperature and also BOD of dry and wet season, showing higher concentrations in wet season.

Table 2. *Seasonal Variation of the Physicochemical Parameters Determined In Effluent.*

PARAMETERS	DRY	WET	P – Value	WHO	NESREA mg/l	FAO
Temp	22.50 ± 0.76^{b}	25.17 ± 0.31^{a}	0.009	Ambient	Ambient	Ambient
pH	7.52 ± 0.45^{a}	7.58 ± 0.38^{a}	0.917	6.5-8.5	6.5-8.5	6.5-9
EC	1020.17 ± 51.40^{a}	914.57 ± 9.48^{a}	0.07	250	-	750
TDS	511.33 ± 20.25^{a}	508.23 ± 136.90^{a}	0.892	1000	-	500
Cl	108.62 ± 3.47^{a}	215.87 ± 6.14^{a}	0.452	250	350	100
PO_4	61.80 ± 9.25^{a}	53.63 ± 6.14^{b}	0.479	3.5	3.5	6.0
HCO_3	5.89 ± 1.026a	4.61 ± 1.21a	0.438	300	200	300
DO	16.13 ± 1.46a	15.00 ± 0.41a	0.472	14	4.0	-
BOD	144.36 ± 6.35b	258.26 ± 15.17a	0.000	30	6.0	30
COD	409.917 ± 86.72a	565.83 ± 79.25a	0.214	-	3.0	-
Na	87.66 ± 8.38a	83.16 ± 5.81a	0.739	200	120	200
K	31.16 ± 2.22a	25.33 ± 3.18a	0.164	12	50	12
NO_3-N	4.12 ± 0.96a	3.74 ± 1.51a	0.835	10	40	50
N	0.92 ± 0.217a	1.00 ± 0.37a	0.852	-	-	-
TSS	16.66 ± 8.027a	25.36 ± 6.51a	0.420	0.03	0.75	25
NH_3-N	0.99 ± 0.14a	0.91 ± 0.40a	0.846	-	-	-
SO_4	8.17 ± 0.14a	12.54 ± 40.04a	0.344	150	500	25

Means with the same superscript across the rows are not significantly different at $p > 0.05$.

4. Conclusion

This study shows that there was little significant difference at $p<0.05$ between physicochemical parameters in dry and wet season of the analysis. However, EC, PO_4^- DO, BOD, COD and K were above permissible limit standard set by WHO, NESREA and FAO. Hence, an indication of inefficient treatment and the need for further treatment to prevent contamination of surrounding surface waters and plant when use for irrigation.

The hospital waste water should be treated before usage to avoid adverse effects and awareness should be made to the public on importance of clean water and preservation of natural resources. There should also be continuous assessment and monitoring of the waste-water treatment plant to ensure effective treatment before discharge to the Environment.

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