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THE INFLUENCE OF INDUSTRIAL EFFLUENT ON CHALLAWA RIVER WATER QUALITY

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ABSTRACT

Water from River Challawa was assessed to test the influence of industrial effluent on the quality of water from the river. Sample collection was done in the month of June, 2023 at the end of dry season. At each sampling three (3) samples were collected to ensure accuracy by replication. A total of twenty-seven samples (27) were collected. Descriptive statistics was carried out on the data. The results obtained were compared with FEPA and WHO standards. A paired sample t-test was also carried out to test for any significant difference in the mean value of parameters upstream and downstream of points of discharge of effluents. Based on the findings of the research, it was concluded that, BOD, TDS and EC at the effluent point before and after have no any significant effect on the quality water from Challawa River. The findings of the study also revealed absence of lead and low concentration of zinc in the water. It was recommended that, the water from River Challawa can be used for irrigation with good management practices.

Keywords: industrial effluent, water quality, River Challawa

INTRODUCTION

Water is a significant natural resources which is essential for all living organisms on the earth. It is essential for various purposes like irrigation, domestic use, industrial purposes, and other uses (Mohammed and Kamaraj, 2021). However, due to human activities, water quality is declining day by day, and it is becoming polluted with various contaminants, including industrial effluents. Industrial effluents are the liquid waste discharged from various industrial activities. This effluent contains a high concentration of chemicals, organic and inorganic pollutants, heavy metals, and others. These pollutants are harmful to aquatic life and human health if consumed (Abu, 2010; Udiba *et al.*, 2018).

Udiba et al., (2018), reported that, "industrial effluents are major pollutants which contaminate not only water bodies but also the entire biosphere. Tannery effluents ranked as high pollutant among all other industrial waste Tanning is a chemical process that converts hides and skin to leathers, which serves as raw materials in footwear and leather industry". Kano city on Latitude. 12^0 02'N, Longitude 08^0 30'E of Northern Nigeria, is significantly faced with both surface and groundwater pollution due to huge leather and textile industrial activities, (Egwuonwu *et al*, 2011).

Bichi (2013), reported that, Kano has 320 industries distributed mainly within the three main industrial estates at Bompai, Sharada and Challawa. The city has 21 tanneries, 24 textiles and 43 food processing industries. In addition, there are over 63 aluminum, metal, wood factories, 50 plastic, rubber and tyre factories and over 32 chemical and cosmetic product industries (Bichi, 2013). Most of these industries do not have waste water treatment facilities and thus discharged their untreated effluent into adjoining receiving water bodies. Effluent from Challawa and Sharada industries are discharged through drains and canal that empties into River Challawa. The river basin is a booming agricultural area. Crops are planted on both sides of the river bank throughout the year. The river is also a major source of water supply to a number of communities located along its course. Other uses of Challawa river are, irrigation, fishing, bathing and drinking (Udiba *et al.*, 2018).

River Challawa served as intake to Tamburawa old water treatment plant, which is located some kilometers downstream of the effluent discharge points. A number of monitoring bodies such as NESREA, Kano State Environmental Agency (KASEPA) and United Nations Industrial Development Organization (UNIDO) have made several efforts to monitor waste treatments and disposal processes in these areas (Salisu and Bichi, 2020). Egwuonwu, *et al (*2011), conducted a study on characterization of topsoil and groundwater at Challawa industrial area, Kano, and observed that, "untreated and inadequately treated effluents and solid wastes produced by the tannery and textile industrial processes are indiscriminately discharged to the surrounding lands and rivers, and that farmers in these areas use the water for the irrigating their farm lands".

Adedokun, and Agunwamba (2015), reported that, "River Challawa is an important resource which supplies water for irrigation, drinking after treatment, agricultural and fishing activities". It was also reported that, self-purification processes in stream enables it to safely handle some wastewater discharges, however there is a limit to its assimilation capacity. The indiscriminate discharge of waste water effluents and municipal sewage into the river may impact negatively on the health of aquatic organisms. therefore, the need for a logical, consistent and regular assessment of the river system as a result of the continuous discharge of effluent from the industrial areas into the river. Dada (1997), reported that, "less than 10 % of industries in Nigeria treat their effluents before being discharged into the rivers. This has led to high load of inorganic metals such as Pb, Cr and Fe in most water bodies (Taiwo *et al*, 2012). The consequences of this increased river pollution include, loss of aquatic life and uptake of polluted water by plants and animal which eventually gets into human body resulting in health-related problems (Dan'azumi an Bichi, 2010).

This study was aimed at assessing the physiochemical parameters of the water -Ph, temperature, electrical conductivity, total dissolved solid, total suspended solids and heavy metals, for the influence of effluents discharged from Challawa industrial layout on the receiving Challawa River water quality from the point source. Water samples collected from Challawa River was analysed to establish the influence of industrial effluent on the water quality and to appraise the level of compliance with effluent permissible standards set by the National Environmental Standards and Regulations

Enforcement Agency (NESREA) and FEPA, and to ascertain the water quality status of the receiving Challawa River.

MATERIALS AND METHODS

Study Area

According to Akan and Ayodele (2020), River Challawa is located on Lat 11° 52' 41" N, Long 08° 28' 09" E, 515m above sea level. It has its source from the Challawa Gorge dam in Challawa village and stretches down to River Kano and empties into Lake Chad. The sources of wastes received by the river include, tanneries and textile industries, urban water storm and agricultural runoff from farming communities along the river course. It is a major source of water supply to a large number of communities along its course. Other uses are irrigation, bathing, fishing and domestic water supply for Challawa, Sharada and Bompai industrial areas and environs, (Salisu and Bichi, 2020).

Sample Collection

The field work commenced with reconnaissance survey to determine the points of discharge of effluent and the types of pollutants emanating from Challawa and Sharada industrial areas. The sampling points were selected at Panshekara, Challawa, Sharada, Magami and Gadar Tamburawa. Samples were collected upstream and downstream of these points in plastic containers. At each point collection three (3) samples were collected to ensure accuracy by replication. A total of twenty-seven samples (27) samples were collected. The plastic bottles used for the sample collection were washed with detergent and rinsed 3 times with distilled water and then with the sample water. The collections were done in the months of June, 2023 at the end of dry season. The solution of nitric (V) acid was used for the stabilization of water samples for heavy metal analysis. Sample bottles were labeled and taken to Bayero University Kano Laboratory, for analysis.

Laboratory Analyses

Digested samples were then filtered into clean plastics sample bottles and the filtrate was made-up to 100ml using distilled water. Atomic Absorption Spectrometer (AAS) Thermo Scientific Model 3000 was used for heavy metal analyses. Standard solution for each metal to be tested was prepared; the AAS machine was powered on and allowed to normalize. The Hollow Cathode Lamps were loaded in their respective positions. Metals to be analyzed were selected from a periodic table in the machine. A blank was run through the machine followed by running a range of prepared standard solutions. The samples were then run one after the other for the determination of each element as required. The pH was determined by electrometric method with pH meter M200, electrical conductivity was determined using conductivity meter 4071. Sodium and Potassium were determined using Flame photometer 400. Volumetric method was used for the determination of Chloride, Carbonate and Bicarbonate. Meanwhile, Magnesium and Calcium were determined by Complexometric titration. Boron by Azomethine-H method, Nitrate and and Ammonium nitrate by Nessler's calorimetric method. Heavy metals were determined using Atomic Absorption Spectrophotometry. The test procedure was in accordance with ALPHA, AWWA and WEF, 2005 standard methods for the examination of water and waste water.

Statistical Analyses

The results of laboratory analyses of water samples were subjected to statistical analysis using Minitab 17. Descriptive statistics was carried out and mean as well as the standard deviation of sampling points was obtained and compared with standard. A paired sample t-test was carried out to test for any significant difference for the mean value of parameters upstream and downstream of points of discharge of effluents.

RESULTS AND DISCUSSION

The result of physio-chemical analysis presented in Table 3.1, reveals that the pH 6.58 and 4.13 of the water both before and after the effluent points respectively falls outside the standard range by both FEPA and WHO. This findings is in contrast with the findings by Danazumi and Bichi (2010), in a similar study conducted on Challawa River, their findings revealed pH of 9.9 which is outside the range. This may be subject to the period of sample collection. TDS, EC and BOD (308mg/l,513µmhos/cm and 0.408mg/l) after the Effluent Point ABP, were found below the maximum permissible limit 2000mg/l, 600µmhos/cm and 30mg/l respectively by FEPA. This is not in line with the findings by Odiba, Ode and Udofia (2018) on the "Pollution Potential of Effluent from Challawa Industrial Layout and its Influence on the Water Quality of River Challawa, Kano, Nigeria". And that conducted by Danazumi and Bichi (2010), all studies revealed concentration above permissible which shows ahigh level of pollution.

Table 1: Result of physio-chemical properties of Challawa River

Element	Location	Mean(STD)	FEPA	WHO
Ph	BEP	6.58(0.22)	6.5-8.5	6-9
	AEP	4.13(3.42)		
EC	BEP	566(648)	600	500
	AEP	513(687)		
TDS	BEP	339 (389)	2000	500
	AEP	308 (412)		
BOD	BEP	0.67 (0.226)	30	-
	AEP	0.408(0.417)		
Cr	BEP	0.1468(0.1839)	0.05	0.05
	AEP	0.1253(0.1960)		
Fe	BEP	10.67(5.72)	0.3	0.3
	AEP	5.67(7.04)		
Mn	BEP	0.1494(0.2124)	0.05	0.05
	AEP	0.1145(0.2191)		
Pb	BEP	nd	0.05	0.05
	AEP	nd		
Zn	BEP	0.0310(0.0593)	1.0	5.0
	AEP	0.0077(0.0074)		

The results for heavy metals assessed revealed that Cr, Mn, Fe and were found above the maximum permissible of FEPA and WHO standard with the exception of Pb which was not detected at any point. This finding is in harmony with findings by Odiba, Ode and Udofia (2018), Salisu and Bichi (2010) and Salisu and Bichi (2020).

Furthermore, Akan et al., (2007), conducted a study on the determination of pollutant levels in water of river Challawa and tap water from Kano industrial areas and found high levels of some contaminants while some are at low concentration.

Figure 1 as shown below is the pictorial representation of the heavy metals and physiochemical parameters of Kano River before effluent point (BEP) of the industries that discharge their liquid waste into the river. Seven effluent points i.e Challawa tanneries, Textile outlet, Textiles, Sharada outlet, Sharada, Magami and Gadar Tamburawa were studied. The Effluent composition before Challawa Tanneries was used as a reference point (Control). As it can be seen from the Ph of the river seems not to have been affected by all of the discharge from the EP (Effluent Point) along the river. However, the EC and TDS of the river drastically increased between Challawa EP and before the textile outlet EP. This give an inference that effluent from Challawa EP is high in EC and TDS. Between the textile outlets EP and before the Sharada EP reduced to almost 10% of their initial value before Challawa EP. This is an indication that the effluents from Textile EP and Sharada outlet EP are less toxic compare with that of Challawa and Sharada. The reduction in heavy metals and other physiochemical parameters between the textile outlets EP and before the Sharada EP may also be as a result of the presence of bi-remediation agents.

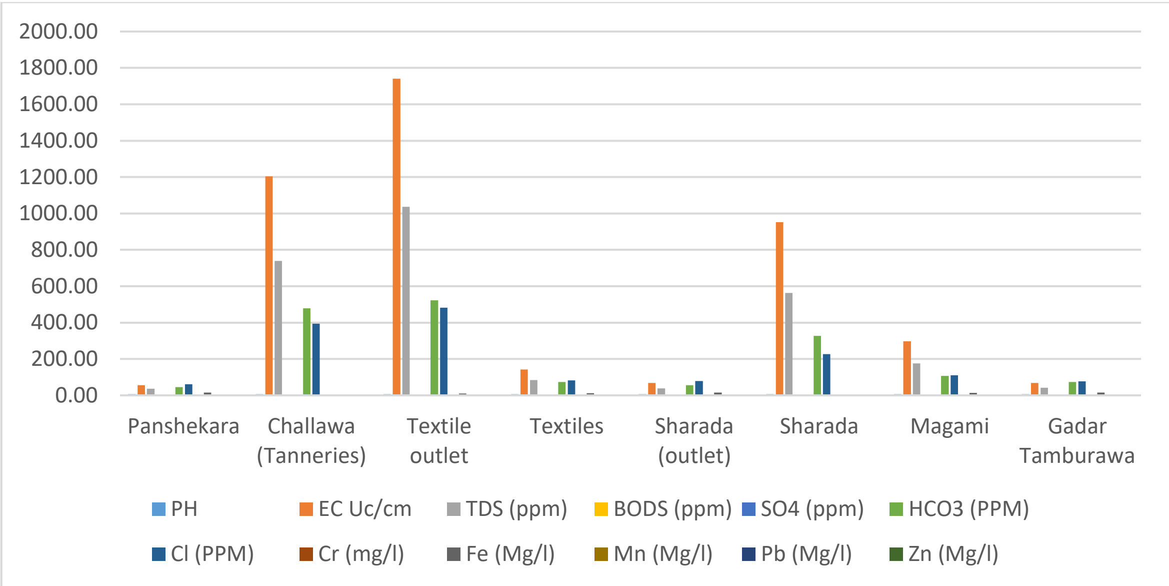

Figure 1: Elemental Composition of Kano River before Effluent Points

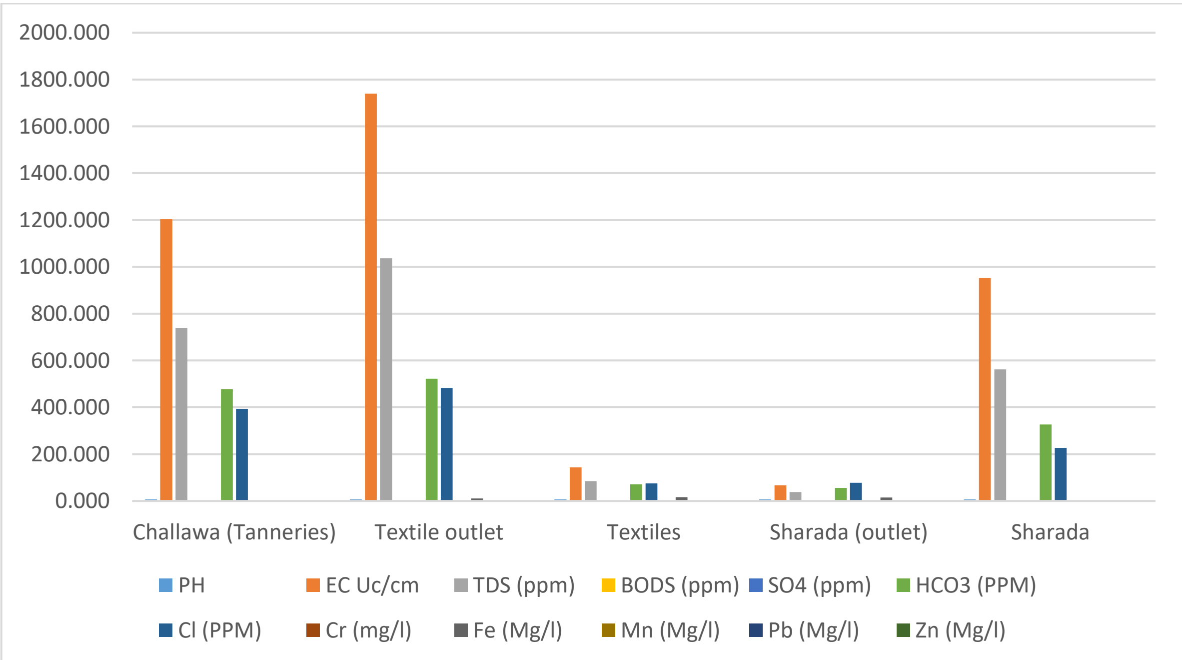

Figure 2: Elemental Composition of Kano River after Effluent Points

Figure 2 is the pictorial representation of the heavy metals and physiochemical parameters of Kano River after effluent point (AEP) of the industries that discharge their liquid waste into the river. Worthy of note is the significant increase in the value of EC and TDS after the EP of Challawa and Textile outlets. The sudden increase in the values of EC and TDS after the EP of Sharada inferred that the effluent from Sharada is also contributing the high levels of EC and TDS the Kano River water.

Descriptive statistics of the heavy metal and physiochemical parameters of River Challawa

Descriptive statistics illustrated the analyses result of heavy metals, toxic ions, and other physico-chemical parameters of Kano River irrigation water. Minitab 19 statistical tool and Microsoft excels software were employed for data analyses. The analyses results of water samples were presented in descriptive texts, tables, and graphs. The effects of effluent discharged into the river from five industries on heavy metals and physiochemical parameters of the river were tested with paired t-test. Variation of heavy metals and selected ions between water sampling locations along the river stream were subjected to ANOVA.

Effects of Effluents from the Factories on the EC of Kano River

A paired-samples t-test was run on EC of 54 water samples from the river to determine whether there was a statistically significant mean difference in EC of water from the river before and after effluents points (EP). From Table 2 it can be seen that generally along the river between Challawa EP and Sharada EP the mean EC after effluent point (AEP) is 513 which is lower than the mean EC 566 before the effluent point (BEP). A statistically significant mean decreases of 53. (95% CI)

Table 2: Descriptive Statistics for Electrical Conductivity (EC)

Parameter/Location	N	Mean	SD	SE
EC (BEP)	8	566	648	229
EC (AEP)	8	513	687	243

Tables 3 and 4 are the estimation for paired difference and test results. Null hypothesis states that the mean difference in EC before effluent point and EC after effluent point is 0. Because the p-value is 0.19, which is greater than the significance level of 0.05, the decision is to accept the null hypothesis and conclude that there is no significant difference in the EC before and after EPs. It is therefore, concluded that the effluents from the seven effluent points along the river does not have any statistically significant effect on the EC of Kano River.

Table 3: Estimation for Paired Difference

Mean	SD	SE	95% µ_Difference
52.7	102.8	36.3	(-33.2, 138.6)

µ_difference: mean of (EC (BEF) - EC (AEP))

Table 4:Test

Null Hypothesis	H_O: µ_difference = 0
Alternative Hypothesis	H_1: µ_difference ≠ 0

T-Value	P-Value
1.45	0.190

Effects of Effluents from the Factories on the TDS of Kano River

A paired-samples t-test was run on TDS of 54 water samples from the river to determine whether there was a statistically significant mean difference in TDS of water from the river before and after effluents points (EP). From Table 5 it can be seen that generally along the river between Challawa EP and Sharada EP the mean TDS after effluent point (AEP) is 308 which is lower than the mean TDS 339 before the effluent point (BEP). A statistically significant mean decrease of 31. (95% CI)

Table 5: Descriptive Statistics

Sample	N	Mean	SD	SE
TDS (BEP)	8	339	389	137
TDS (AEP)	8	308	412	146

Table 6: Estimation for Paired Difference

Mean	SD	SE	95% CL for µ_ difference
31.8	61.1	21.6	(-19.2, 82.9)

µ_difference: mean of (TDS (BEP) - TDS (AEP))

Table 7: Test

Null hypothesis	H_o: µ_ difference = 0
Alternative hypothesis	H_1: µ_ difference ≠ 0

T-Value	P-Value
1.47	0.184

Tables 6 and 7 are the estimation for paired difference and test results. The null hypothesis states that the mean and standard difference in TDS before and after effluent point. is 0. This is indicative for the fact that, p-value is 0.184, which is greater than the significance level of 005. Therefore, the decision is to accept the null hypothesis and conclude that there is no significant difference in TDS before and after EPs. It is therefore, concluded that the effluent from the seven effluent points along the river does not have any statistically significant effect on the TDS of Kano River.

Effects of Effluents from the Factories on the BOD of Kano River

A paired-samples t-test was run on TDS of 54 water samples from the river to determine whether there was a statistically significant mean difference in BOD of water from the river before and after effluents points (EP). From Table 7 it can be seen that generally along the river between Challawa EP and Sharada EP the mean TDS after effluent point (AEP) is 0.408 which is lower than the mean BOD 0.671 before the effluent point (BEP). A statistically significant mean decreases of 0.263. (95% CI)

Table 8 Descriptive Statistics

Sample	N	Mean	SD	SE
BOD (BEP)	8	0.671	0.226	0.080
BOD (AEP)	8	0.408	0.417	0.147

Table 9: Estimation for Paired Difference

Mean	SD	SE Mean	95% CI forμ_ difference
0.263	0.311	0.110	(0.002, 0.523)

μ_difference: mean of (BOD (BEP) - BOD (AEP)

Table 10: Test

Null hypothesis	H_0: μ_ difference = 0
Alternative hypothesis	H_1: μ_ difference ≠ 0
T-Value	**P-Value**
2.38	0.049

Tables 9 and Table 10 are the estimation for paired difference and test results. Null hypothesis states that the mean difference of BOD before effluent point and BOD after effluent point is 0. Because the p-value is 0.049, which is less than the significance level of 0.05, the decision therefore is to reject the null hypothesis and conclude that there is significant difference in the BOD before and after EPs. It is therefore, concluded that the effluence from the seven effluent points along the river have statistically significant effect on the BOD of Kano River..

CONCLUSION

The study of these physio-chemical properties provides information that will help in formulating policies that will help in the management of surface water for domestic, industrial and agricultural use in Kano State. Based on the outcome of this investigation, it is concluded that, BOD, TDS and EC at the effluent point (EP) before and after have no any statistically significant effect on the water quality of Challawa River.

It shows that, effluent from Sharada also contribute to the high levels of EC and TDS of water from Challawa River Kano. Meanwhile, Pb was not detected throughout the study area. While Zn was found to be present at a very low concentration. Thus concluded that, the water from River Challawa can be used for irrigation with mild amendments.

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