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SOME PHYSICOCHEMICAL PARAMETERS OF MAKERA DRAIN, KADUNA, NIGERIA

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ABSTRACT

The study was conducted to monitor some physicochemical parameters of Makera Drain, in order to ascertain its levels of pollution. The parameters were determined using standardized procedures. The result revealed that water temperature was 26.9±0.548°C, which was slightly higher than the air temperature 26.2°C ±0.735; velocity of the flow was 0.3±1.10m/s while depth was 25.8±2.15cm, other parameters and their values obtained were turbidity 61.2±12.4NTU, total solid 1670.3±301mg/l, pH 8.9±2.15, electrical conductivity 789.3±141µs\cm, total hardness 94.5±9.27mg/l, total alkalinity 274.0±34.8, dissolved oxygen 8.6±1.75mg/l, BOD 223.3±64.8mg/l, COD 1130.4±190mg/l, chloride 67.0±4.78mg/l and PO_4-P 70.5±18.2mg/l. There was high significant positive correlation (P< 0.01) between the amount of TS, Water Temperature and Turbidity while analysis of variance showed variations between months, stations and seasons.

KEYWORDS : physicochemical parameters, Makera drain

For a long time, Africa was thought to be safe from aquatic pollution, but rapid population growth of recent years accompanied by intensive urbanization and increase in industrial activities have led to steady increase in the quantity and diversity of discharges that reach the aquatic environment (FAO, 1991). High concentrations of these wastes have adverse effect on the physico-chemical properties of the receiving water, which consequently affects human that use the water and the biota in the water bodies. In Nigeria, the major industrial cities are Lagos, Port Harcourt, Kano Ibadan and Kaduna. In some of these industrial establishments, it is a common sight to observe coloured effluents emanating from their premises into public drains. Thus drains, rivers and lagoons in these cities contain various concentrations of industrial and domestic pollutants. For instance, River Kaduna separate Kaduna into North and south, the river is the main source of water supply to the city, its numerous industrial establishments and surrounding environs. The industries discharge over 500,000m^3/day of untreated effluents into the River. (FME, 2002), through about 53 tributaries, Makera drain is one of such that drain effluents from Makera settlement, it receives about 216,700m^3/day of discharge effluents from industries such as United Nigerian Textile Plc (UNTL) Kaduna Textiles Limited (KTL), Nigerian Brewery Limited (NBL), Chang change oil depot, and Norspin (Beecroft, 1987 and FME, 2002). The question that often readily comes to mind centers around toxicity of these effluents and their possible effects on human and aquatic life which depend on the drain water for sustenance and human which there main water supply is processed from river kaduna. Unlike River Kaduna where studies of physicochemical parameters had been extensively investigated there is scanty information on the physicochemical parameters of Makera drain, therefore this study was conceived with the aim to determine the monthly and seasonal variation of some physico-chemical characteristics of Makera drain.

MATERIALS AND METHODS

Sample Collection and Analysis

Water samples were collected monthly at four sampling points (Fig.,1). Sampling point 1 receives domestic waste from the residential area. Point 2 is the beginning of the drain where it receives effluents from KTL. Point 3 is the confluence of on-stream and upstream, while point 4 receives waste from UNTL and Chanchangi Company. The Water sample were collected in a two (2) litre plastic jar; the jars were then be screwed tight, placed in a plastic box containing ice and transported to and transported to chemical laboratory of Kaduna Refinery Petrochemical Company (KRPC) for analyses.

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Physico-Chemical Parameters Determination

Air and water temperature, pH, Conductivity and Total dissolved solids was measured in-situ using a HANNA portable combo waterproof pH/EC/TDS/ Temperature, Tester model HI 98130.Transparency was evaluated using standard 20cm diameter Secchi disc . Water velocity was determined using the Pin-pong floatation technique and Water Depth was measured with the use of graduated ruler and robe. Dissolved Oxygen (DO) was determined using Digital D.O meter model 6 11-R Labtech.

In the laboratory Biological Oxygen Demand (BOD) was determined by modified Winkler Azid method while Total Hardness and Chloride were determined by the method described in (Lind, 1979).

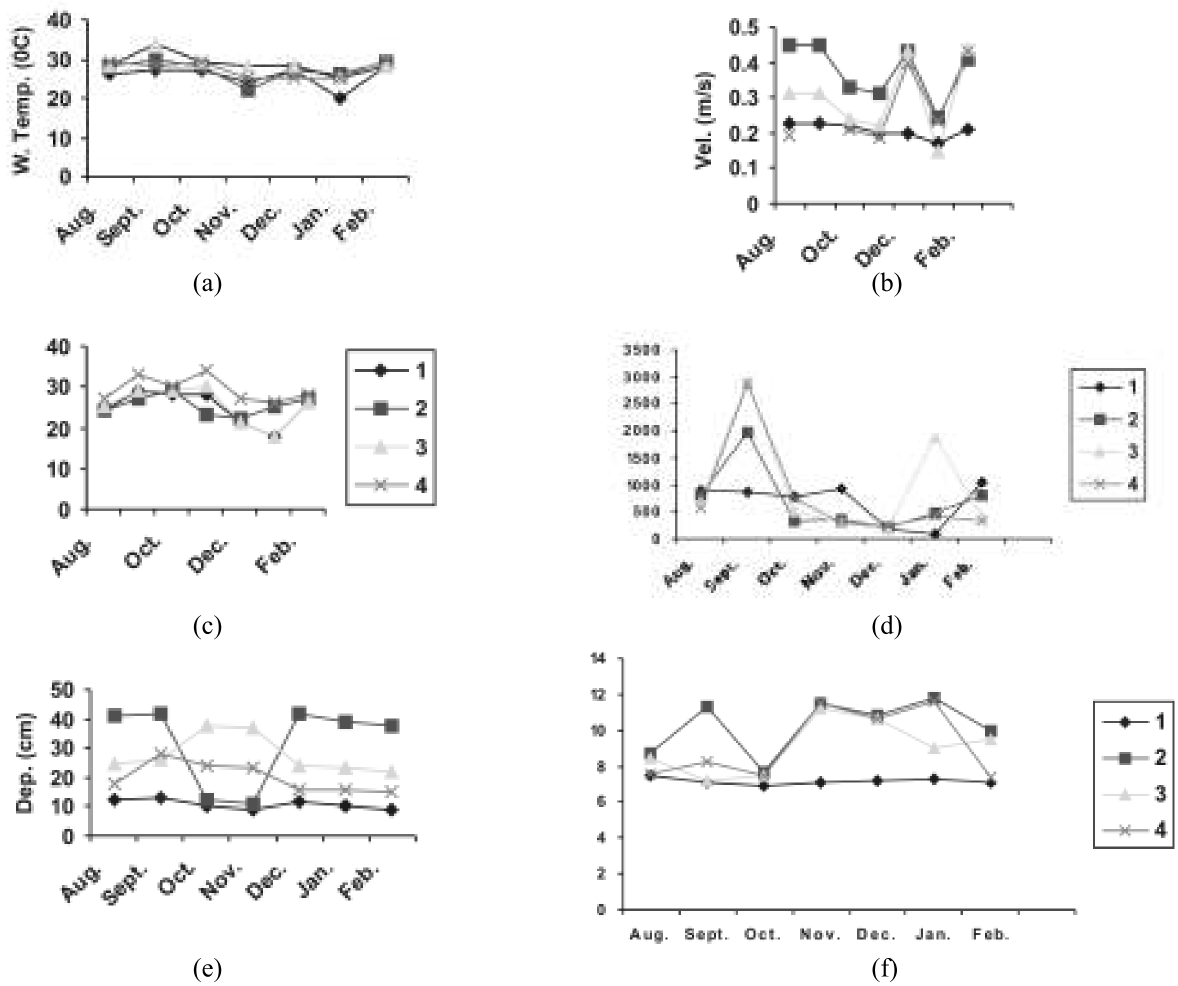
Chemical Oxygen Demand (COD), Alkalinity, Nitrate- Nitrogen, Sulphate and Phosphate-Phosphorus were determined in accordance with ASTM, (2001).

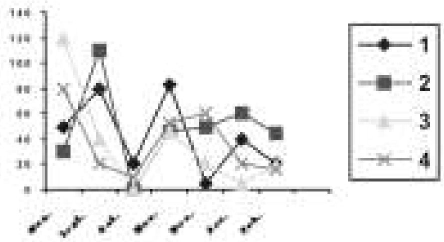
The parameters measured had their values analysed statistically in addition to the graphic presentations of the variations. Individual and combined analysis of variance (ANOVA) was used to determine the level of significance among the parameters measured, and where significant, Duncan multiple range test (DMRT) was used to separate the means. Correlation coefficient was used to determine relationship between the different parameters.

RESULTS

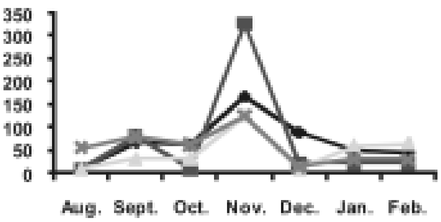
The highest monthly mean temperature of 29.8°C was observed in the month of September during the wet season while the lowest 22.8°C was recorded in the month of November during the dry season (table, 2). There was significant variation ($P < 0.01$) of surface temperature for the stations, months and seasonal means. Duncan multiple range test (DMRT) revealed significant difference between

Fig.1:Grapgical representation on Physico-Chemical Parameters of Makera Drain, Kaduna

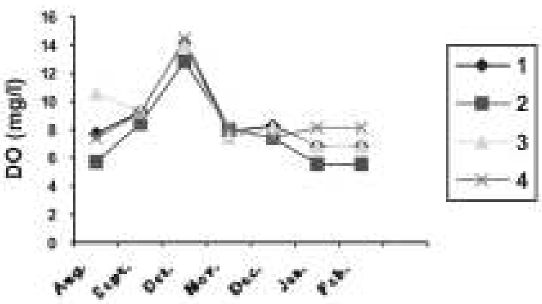



1
2
3
4

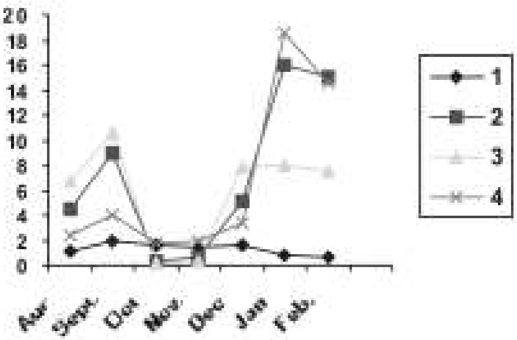
(g)


350
300
250
200
150
100
50
0
Aug. Sept. Oct. Nov. Dec. Jan. Feb.

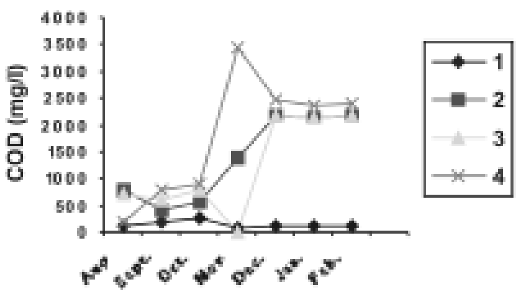
(h)


DO (mg/l)
16
14
12
10
8
6
4
2
0
Aug. Sept. Oct. Nov. Dec. Jan. Feb.
1
2
3
4

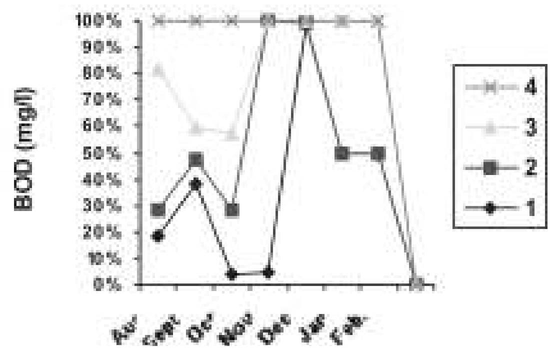
(i)


20
18
16
14
12
10
8
6
4
2
0
Sept Oct Nov. Dec Jan Feb.
1
2
3
4

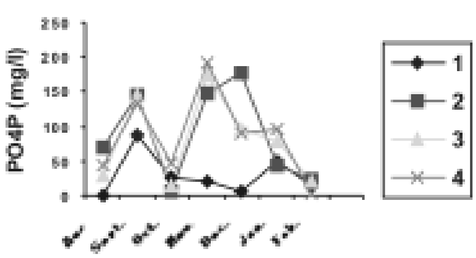
(j)


COD (mg/l)
4000
3500
3000
2500
2000
1500
1000
500
0
Aug Sept. Oct. Nov Dec. Jan. Feb.
1
2
3
4

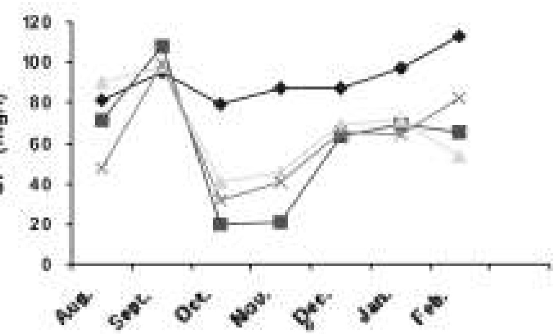
(k)


BOD (mg/l)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Sept Oct Nov Dec Jan Feb.
4
3
2
1

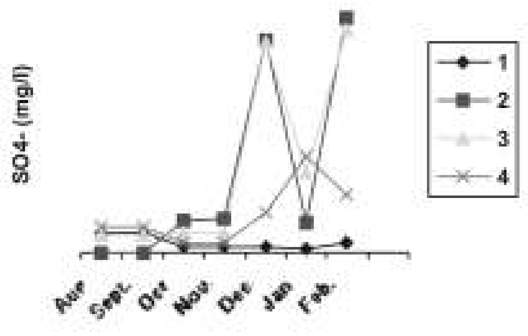
(l)


PO4P (mg/l)
250
200
150
100
50
0
Sept. Oct. Dec. Jan. Feb.
1
2
3
4

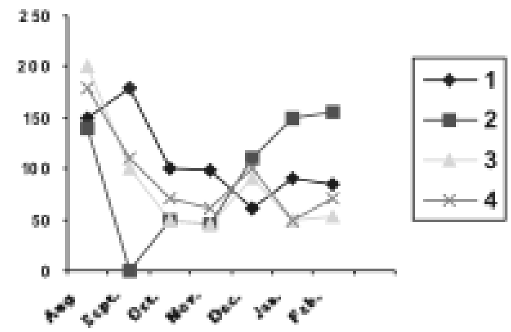
(m)


Cl- (mg/l)
120
100
80
60
40
20
0
Aug. Sept. Oct. Nov. Dec. Jan. Feb.

(n)



(o)



(p)

the mean temperatures at all stations and throughout the months within the two seasons.

Station 1 had the lowest depth of 9.0cm in the dry season while station 2 was found to be the deepest with 41.5cm in the month of Nov . The drain was more turbid 186.3NTU in the dry season than the wet season with 21.3NTU (Table,1). There was no significant difference between water turbidity mean at all stations and months except for the month of November and the two seasons according to DMRT (Table,3). The mean value of total solid was higher in the month of Nov with 3408.29mg/l than the wet season of 144.83mg/l (Table, 1). Analysis of variance (ANOVA) shows that season had highly significant variation in total solids, but months and stations are not significant (Table, 2). The drain water was alkaline in nature except for station 1 which had neutral pH while the highest value in the month of Nov was in station 2. Analysis of variance (Table,2) indicates a highly significant difference in mean water pH between months, stations and seasonal mean. Mean seasonal variation shows that during the wet season, the highest EC (2154.75) was observed while the lowest EC of 202.00 was in the dry season (Table,1). Mean seasonal variation shows that during the wet season, the highest Ca/hard (93.33mg/l) was observed in station 1. During the dry season, the highest Ca/Hard (62.5mg/l) was recorded in station 2. Stations 3 and 4 recorded the lowest Ca/Hard of 63.33mg/l and 33.25 mg/l, in the wet and dry seasons respectively (Fig,1).The highest mean seasonal variation during the wet and dry season were observed in stations 1 (50.0mg/l) and 4 (37.00mg/l) respectively while in stations 4 and 3 the lowest Mg/Hard (36.67mg/l and 22.5mg/l) were observed respectively . The highest NO_3-N values 18.5mg/l was obtained in the month of Jan at station 4 while the lowest 0.1 mg/l was recoded in the month of Oct in station 3. Table,2 Analysis of variance shows high significant variation within stations and months and significant variation within seasons. There was insignificant difference between NO_3-N with stations months and seasonal mean according to DMRT ((Table,3).Mean monthly seasonal variation showed that the highest values 1720.8mg/l for COD was in dry season and 450.0mg/l value the lowest in the wet season (Table,1). DO mean seasonal variation of 10.35mg/l in wet and dry seasons was recorded in stations 1 and 4 respectively, while the lowest values 9.0mg/l and 5.9mg/l were observed in stations 4. The mean seasonal variation in BOD highest 616.30mg/l was in the dry season while the lowest value recorded during wet season was 60.07mg/l (Table,3). DMRT revealed significant difference in COD within months and stations, but no significant difference within the seasons. DO have no significant differences with the months, stations and seasons. While BOD had significant differences with months but not within stations and seasons (Table,4). The mean seasonal variation of PO_4-P, recorded during the wet season varied from 38.2mg/l the highest in station 1 to 73.9mg/l the lowest in station 2 and 4, while station 3 recorded the highest (915.8mmg/l) and station 1 the lowest (21.8mg/l) during the dry seasons . The analysis of variance (Table,2) shows high significant variation in stations, months and seasons. Station 1 recorded the highest chloride concentration (112.8mg/l) during the dry season while the lowest concentration was observed in stations 2 (19.8mg/l). The mean separation of Chloride shows significant difference within month, stations and seasons (Table,3).

DISCUSSION

Physico Chemical Parameters

The physico chemical parameters measured served as an indication of water quality. High temperatures of the wet season and low in the dry season may be attributed to the characteristic cool dry North East trade winds which is typical of the seasons. Slightly high surface temperature than air temperature could be attributed to water used for processing and cooling of machines that is discharged directly into the drain from the industries. This is contrary to the findings of Adeniji, (1991) on Jebba lake and Araoye, (2002) on the Asa lake.

The highest mean depth obtained at station 2 in both seasons may be due to the continuous discharge from Kaduna Textile Ltd (KTL) and rainfall during the wet

Table 1: Mean Values of Some Physico Chemical Parameters of Makera Drain

Months / Parameter	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	SE	CV (%)
W. Temp. (^{0}C)	27.80	29.8	28.3	22.8	26.8	24.0	28.8	0.548	0.0
A. Temp. (^{0}C)	25.0	29.5	29.0	28.8	22.8	21.8	26.8	0.735	5.0
Dep. (cm)	24.0	27.3	21.0	42.5	23.25	22.1	20.9	2.15	40.7
Tur. (NTU)	21.3	64.5	42.0	186.3	33.3	41.0	40.0	12.4	67.2
Vel. (m/s)	0.29	0.29	0.25	0.23	0.37	0.20	0.37	1.10	22.3
TS (mg/l)	755.64	144.83	1119.77	3408.29	2837.25	585.28	2841.22	301	28.5
DS (mg/l)	717.26	495.48	1073.34	2235.13	2469.64	517.06	2470.96	264	58.6
SS (mg/l)	68.63	85.96	46.42	1170.05	367.61	43.22	368.75	82.9	0
PH	8.1	8.5	7.4	10.3	9.8	9.9	8.5	2.15	4.46
EC (m)	737.75	2154.75	595.75	474.00	202.00	712.00	648.75	141	44.5
T/Hard (mg/l)	167.5	97.5	67.5	62.8	90.5	85.0	90.8	9.27	43.1
Ca/Hard (mg/l)	97.5	90.0	62.5	6.3	57.0	51.3	65.8	6.17	0
Mg/Hard (mg/l)	70.0	62.5	7.5	56.5	33.5	31.3	25.0	6.00	68.9
AlK	162.5	225.0	225.0	146.5	202.0	469.8	487.0	34.8	53.7
No_3^-N	4.0	6.4	1.0	1.1	4.5	10.8	9.4	1.0	93.7
COD	450.0	496.8	622.3	1227.8	1720.8	1690.4	1704.4	190	68.1
DO	7.85	9.05	13.88	7.83	7.82	6.85	6.85	1.75	17.8
BOD	60.07	108.41	476.65	154.35	616.30	73.75	73.75	64.8	104.9
PO_4^-P	35.28	128.58	22.48	133.23	92.09	66.65	15.03	18.2	107.9
Cl^-	72.65	100.00	42.70	48.68	71.33	75.63	58.00	4.78	21.6
SO_4^-	25.50	25.50	26.25	27.75	184.50	81.75	206.95	3.0	79.3
S.Silica	11.80	11.80	18.95	37.32	45.2	62.57	62.57	0.02	0
W. silica	1.64	1.64	2.99	0.41	0.31	0.30	0.60	0.83	34.7

Table 2: Analysis of Variance (ANOVA) for Physico-Chemical Parameters of Makera Drain, Kaduna

Source of Variation	DF	Mean square										
		W. Temp.	A. Temp.	Dep	Tur.	Vel.	TS.	DS.	SS	pH	EC.	T/Hard
Treatment	10	22.743**	37.905**	205.913**	8689.012*	33.042*	6441866.94**	4074502.14**	519466.323	8.263**	1284067.08	2669.083*
Station	3	6.381**	29.762**	623.167**	873.940**	35.473**	3274610.30*	3616563.02**	21512.083**	11.533**	133372.714	769.000
Month	6	26.488**	39.119**	24.342**	2834.476	33.077**	6165286.47*	3439623.61*	663670.886**	4.815**	1582762.50	4796.917*
Season	1	62.574**	55.048	43.574	7261.440*	25.533**	17603119.63**	9257590.96**	1211929.120**	19.143**	2943944.636	5602.333*
Error	17	0.002	1.745	84.959	1689.646	34.091	242938.83	699326.09	0.003	0.158	123484.54	1662.363
Total	37	118.188	163.579	981.955	21348.514	161.216	33727822.17	21087605.85	2416578.415	35.649	6067628.48	16499.696

Table 2 continued: Analysis of Variance (ANOVA) for Physico-Chemical Parameters of Makera Drain, Kaduna

Ca/Hard.	Mg/Hard	AlK	$P0_4^-P$	COD	DO	BOD	NO_3^-N	$C1^-$	SO_4^-
2878.296**	1372.554*	58136.832*	55.749**	2654785.41**	70.135*	209105.054*	7933.484**	1344.113**	28510.9844
905.369**	247.845	49816.807*	50.492*	3435793.55**	62.723*	61167.776**	8177.810**	1493.851**	21010.5971**
3536.785**	2048.654*	60638.655*	58.788**	1415802.91**	85.471**	301768.686*	7504.854**	1481.726**	2570.2800**
10043.360**	700.074**	68086.574*	53.281**	7745656.04**	0.351	96935.094**	9772.289*	69.215*	67870.3725**
0.005	793.244*	19688.256	12.865	40645.15	94.802	63974.072	10009.598	227.203	4289.4692
17363.815	5162.387	256367.124	231.175	15292683.06	313.488	732950.682	43398.035	4616.108	147382.7032

*, **, Indicate Significance at 5% and 1% probability level respectively.

Table 3: Variation in Physical Parameters of Makera Drain, Kaduna

Variables	W. Temp.	A. Temp.	Dep.	Tur.	Vel.	TS	DS	SS
Month								
August	27.8d	25.0b	24.0a	21.25b	0.30a	748.1b	717.3a	69.0e
Sept.	29.8a	29.5a	27.3a	64.5b	0.30a	579.3b	495.5c	86.0a
Oct.	28.3c	29.0a	21.0a	42.0b	0.25a	1119.8b	1073.3bc	46.0f
Nov.	22.8g	29.8a	20.0a	186.3a	7.90a	3408.3	2238.1ab	1120.0a
Dec.	26.8e	22.8c	23.3a	33.3b	0.37a	2837.3	2469.6a	368.0c
Jan.	24.0f	21.8c	22.19	41.0b	0.20a	585.3b	517.1c	42.0g
Feb.	28.8b	26.8b	20.9a	40.0b	0.37a	2841.0a	2471.0a	369.0b
Station								
Stat. 1	25.57d	24.86b	10.64c	7.00g	0.21g	1253.1b	920.7b	236.4b
Stat. 2	27.14b	25.29b	32.07a	69.7a	4.76g	2745.0a	2487.4a	243.3d
Stat.3	27.86a	25.43b	27.86ab	47.71g	0.30g	1506.0b	1229.5b	281.7c
Stat. 4	26.86c	29.29a	20.00bc	56.29a	0.26a	1421.1b	1066.3b	367.5a
Season								
Wet	28.58a	27.83a	24.05a	75.12a	2.21a	2418.0a	1923.9a	482.4a
Dry	25.56b	25.00b	21.56a	42.58a	0.28a	815.0b	762.0b	67.0b

Means with the same letter in the same column are not significant according to DMR

Table 4: Variation in Chemical Parameters of Makera Drain, Kaduna

Variable	PH	Con.	T/Hard	Ca/Hard	Mg/Hard	AlK	PO_4-P	COD	DO	B D	NO_3^-N	CI	SO_4^-
Month													
August	8.1b	742.9b	167.50	97.50a	70.009	162.50c	3.700bc	450.0c	7.825a	50.1b	132.25a	72.65b	25.50b
Sept.	8.5b	2154.8a	97.50b	90.00b	62.50a	225.00bc	6.350abc	496.8c	9.045a	108.4b	125.58a	100.00a	25.50b
Oct.	7.4c	595.7b	67.50b	62.50d	7.50b	225.00bc	0.975c	622.2c	13.875a	774.3a	82.11a	42.55c	26.25-b
Nov.	10.3a	474.0b	62.75b	6.25a	56.50a	146.50c	1.100c	1227.7b	7.825a	154.4b	132.47a	48.65b	27.75b
Dec.	9.8a	202.0b	90.50b	57.00e	33.50ab	202.00ab	4.500bc	1720.7a	7.817a	466.3ab	92.109	71.32b	184.50a
Jan.	9.99	712.0b	85.00b	51.25f	31.25ab	469.75a	10.825a	1690.4a	6.850a	73.7b	66.65a	75.62b	81.75b
Feb.	8.5b	648.7b	65.75c	65.75ab	25.00ab	397.00ab	9.425ab	1704.4a	19.45a	73.7b	15.03a	78.6ab	206.95a
Station													
Stat. 1	7.17e	681.7g	109.14a	66.80b	42.29a	268.0ab	1.329b	143.4c	8.705a	121.8a	62.8g	91.35g	15.87b
Stat. 2	10.23a	708.6a	93.00g	74.27a	48.71a	316.00a	7.229a	1369.7b	14.874a	306.6a	87.31a	59.80b	122.00a
Stat.3	9.06b	986.9g	84.29a	48.57d	35.71a	139.71b	5.857a	1219.9b	8.998a	217.8a	79.07a	66.91b	132.50a
Stat. 4	9.20b	782.9a	91.57a	56.14c	36.86a	320.71a	6.657a	1788.5a	8.975a	325.7a	141.70g	61.60b	60.03ab
Season													
Wet	9.64a	64.4a	110.83a	83.33a	33.81a	6.463a	1585.83a	10.49a	310.93a	114.3a	71.73a	31.73a	25.75b
Dry	7.97b	509.2b	82.25a	45.06a	204.19a	3.68a	523.02b	10.26a	192.04a	76.56a	68.56a	17.29b	125.24a

Means with the same letter in the same column are not significant according to DMRT

season and the high velocity in station 2 observed in this study can also be attributed to high discharge from (KTL) into the drain thereby increasing the water movement. High values of these parameters were observed by (Ikomi et al.,2003), and attributed it to rainfall influence. Furthermore, electrical conductivity and concentrations of major ions increase with increase in depth (Ashton and Schoeman, 1983). The high turbidity observed during the dry season may be attributed to the inputs from domestic and industrial effluents. Turbidity is primarily caused by either colloidal or very finely divided suspended particles which settle slowly. The increase in the concentration of total solids from wet to dry season could be attributed to absence of rain in the dry season, increase release of domestic and industrial effluents into the drain. It is also probable that domestic sewage inputs from up-stream decomposed into fine particles thereby increasing the detrital load.

The slight fluctuation of alkaline condition of the drain may be associated with spent sour (a combination of alkaline agent and detergent) discharge from the textile industries into the Makera drain. (Tyokumbur et al., 2002), on Awba stream and reservoir observed high level of alkalinity and attributed it to dry season in which the study was carried out. The high electrical conductivity is a pointer to the ionic concentration and the eutrophic status of the drain. The lower electrical conductivity recorded in station 1 may be due to the high presence of domestic waste relative to the industrial effluents. Umeham ,(1989) opined that electrical conductivity of surface water coupled with its shallowness could be used to assign a high morphoedaphic index to a water body.

The concentration of chloride in the drain was high in site 1 throughout the study period; the proximity of this station to liquid point source and the location in the drain suggest that domestic sewage input is responsible for the enrichment, especially as urine contains variable amounts of chloride ions.

The high PO_4-P in the drain during the dry season may be due to artificial fertilizers applied to the farms on the banks of the drain, which was washed into the drain during the wet season and concentrated as the drain water reduces due to evaporation and absence of rainfall. Wade, (1985) working on two mine lakes in Jos, Nigeria, also observed that increased phosphate-phosphorus in the lakes was a result of artificial fertilizer washed into the water bodies from the surrounding farms. The lower PO_4-P in the wet season may be due to either dilution from rain or fast uptake by the phytoplankton.

The higher concentration of nitrate nitrogen in the dry season than the wet season could have originated from industrial and domestic waste. Gelinas et al., (1996) linked nitrate-nitrogen origin to improper disposal of human excreta and domestic sewage. Nitrate concentration of 45mg/l in water used for baby's food will result in "blue baby syndrome" which is caused by a reaction known as meta-haemoglobin infartile mortality (WHO, 1994).

CONCLUSION

This study revealed marked variations in the mean monthly pH, temperatures, TS, EC, PO_4^-P, SO_4^- and Cl^- of Makera drain. The drain should be converted into covered sewer. Industries should be given a deadline over discharges with pollution load above a specified level. Also Government should sponsor intensified monitoring activities, modeling effort and treatment studies on industrial wastes in conjunction with Environmental biologist.

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