EFFECT OF EFFLUENT FROM SOAP INDUSTRY ON THE PHYSICO- CHEMICAL PARAMETERS OF NEARBY WELL WATER

Liasu M. Ayotunde* and Okoya A. Adetutu
Institute of Ecology and Environmental Studies,
Obafemi Awolowo University, Ile-Ife, Nigeria

*Correspondence author email: liamayotunde77@gmail.com

INTRODUCTION

- Human activities and industrialization alter water quality by polluting the environment.

- Effluent discharges into the environment have been on the increase in Nigeria since 1960 due to industrialization and urbanization accompanying by increase in commercial activities (Ajayi and Osibanjo 1981).

INTRODUCTION CONT'D

- Soap effluent contains spent sodium hydroxide, oil, solvents and some organic compounds. The untreated effluent containing such substances appear cloudy due to large amount of suspended matter and has extremes of pH.

- Improper disposal of industrial wastes can result in a wide variety of contaminants being introduced to the groundwater (Akastal, 1989).

INTRODUCTION CON'TD

- Groundwater contaminants include heavy metals, volatile and semi-volatile organic compounds, highly acidic or basic solutions, solvents and nutrients; factors of natural or artificial activities around the water body.

- However, at Surulere Community in Osogbo, families and communities depend on hand-dug wells for domestic activities.

STATEMENT OF RESEARCH PROBLEM

- Effluent from a soap industry is being discharged into an open drainage close to some wells in Surulere area of Osogbo. Water from the wells are coloured indicating possible effluent pollution. There is therefore the need to assess the effect of the effluent on the water quality, hence this study.

Objectives of the Study

The specific objectives of the study are to

- determine the physico-chemical parameters of the effluent discharge from the soap industry;

- determine the physico-chemical parameters of the water from the wells located in the area around the effluent open drainage; and

- determine the impact of the effluent on the well water.

Expected Contribution to Knowledge

- The study will provide information on the impact of the industrial effluent on the water quality in the study area.

METHODOLOGY

- Wastewater from a Medicated Soap Industry, Osogbo was collected weekly for four weeks .

- Water samples were collected from seven identified wells, five located on one side of the open drainage through which effluent passed and two others were located at the other side of the open drainage (separated by a single lane road, Fig. 1).

Fig. 1 showing drainage pattern of the effluent

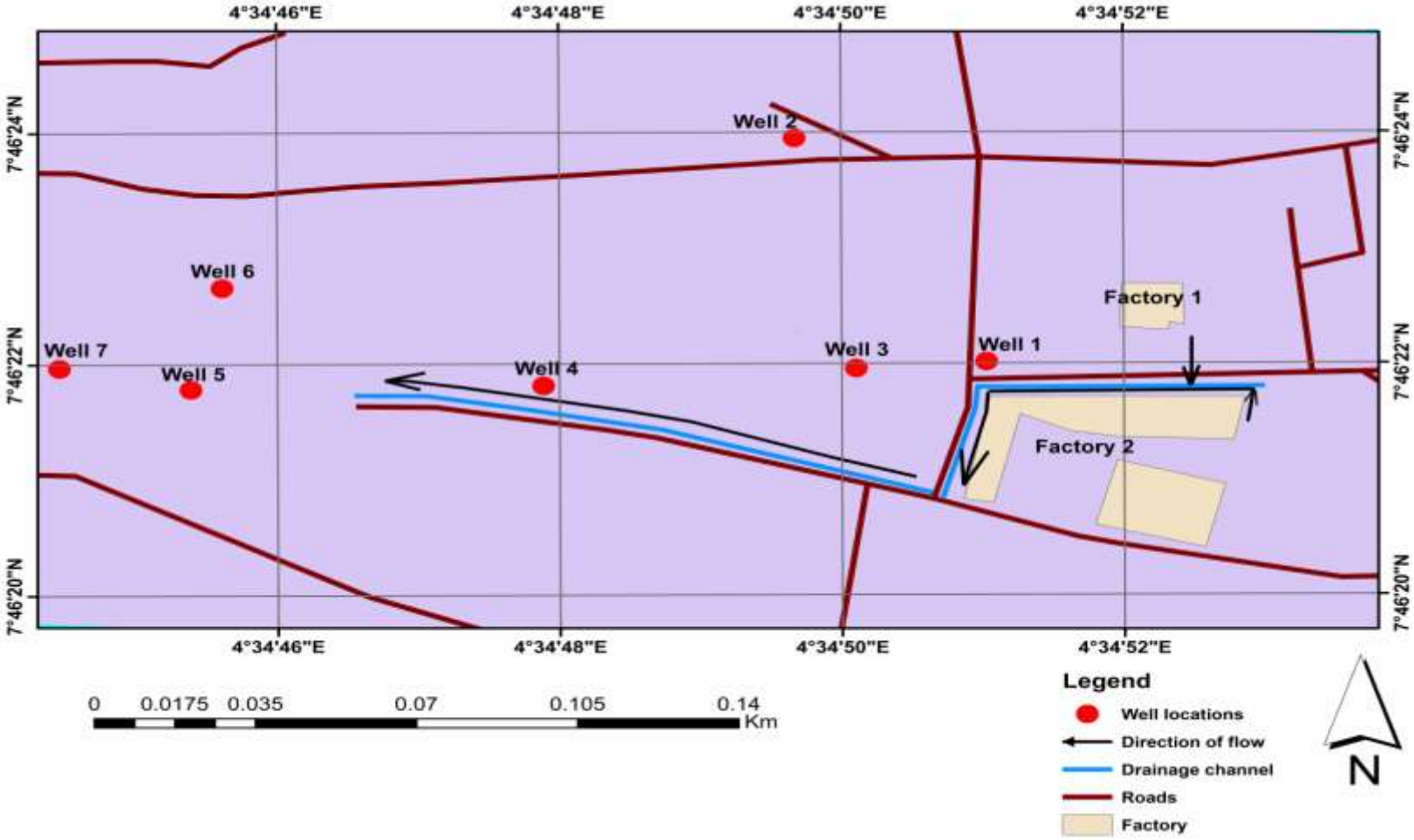

Figure 2: Showing the location of the study site

METHODOLOGY CON'TD

- Water collecting device used by the residents was employed to obtain water samples from the hand-dug wells, while water from pump fitted wells were collected directly from the taps' head.

- Separate samples were collected in DO and BOD bottles, and two and half litres' plastic sampling bottles for other parameters. Temperature was determined *in-situ*, DO was fixed on site while other physico-chemical parameters were determined in the laboratory.

- Well water sampling was carried out twice each during the wet (July and August, 2013) and the dry (December, 2013 and January, 2014) seasons .All the samples (both well water and wastewater) were analysed for physico-chemical parameters using standard methods (Table 1)

METHODOLOGY CON'TD

Table1: Showing parameters and methods

PARAMETERS	METHOD / INSTRUMENT	REFERENCE
Dissolved Oxygen (DO), Biological oxygen demand (BOD)	Titrimetry (Winkler Method)	Golterman *et al.* (1978)
Water Temperature	Thermometer	APHA (1998)
Acidity/Alkalinity (Carbonate)	Titrimetry	Golterman *et al.* (1978)
pH	pH meter	APHA (1998)
Colour/Turbidity	Colorimetry	APHA (1998)
Conductivity/ Total dissolved solids (TDS)	Conductivity meter	APHA (1998)
Total suspended solids(TSS)	Gravimetry	APHA (1998)
Nitrate (NO_3^-)	Spectrometry	APHA (1998)

METHODOLOGY CON'TD.
Table1 cont.

PARAMETERS	METHOD / INSTRUMENT	REFERENCE
Sulphate (SO_4^{2-})	Turbidimetry	APHA (1998)
Chloride (Cl^-)	Mercury Nitrate/Titrimetry	APHA (1998)
Phosphate (PO_4^{3-})	(Vanado-molybdo Phosphoric Acid) Colorimetry	APHA (1998)
Chemical oxygen demand (COD)	Titrimetry (Wet-Oxidation)	APHA (1998)
Na, K, Mg, Ca, Cd, Cr, Cu, Fe, Mn, Pb and Zn	Atomic Absorption Spectrophotomery (AAS)	APHA (1998)

METHODOLOGY CONT.

- Mean±S.D were calculated for effluents, while mean±SD and one-way analysis of variance (ANOVA) were used to compare the mean values of observation based on sampling locations in well waters. Differences in mean values obtained were considered significant if calculated P-values were < 0.05.

RESULTS

The results are presented in Tables 2-6 below

Table 2: Mean values of physico-chemical parameters of soap effluent

Parameters	Week 1 (Mean ±S.D)	Week 2 (Mean ±S.D)	Week 3 (Mean ±S.D)	Week 4 (Mean ±S.D)
Water Temp ^{o}C	28.75±0.028	28.29±0.042	28.80±0.141	28.50±0.283
Apparent Colour (Pt.Co.)	3050.75±0.028	2922.8±0.001	3146.71±0.141	3114.73±0.042
Turbidity (NTU)	307.45±0.071	300.9±1.273	320.5±0.707	317.25±0.071
pH	10.21±0.141	6.180±0.014	6.160±0.028	10.22±0.156
Acidity ($mgCaCO_3/L$)	0.000±0.000	62.00±2.828	164.0±5.657	0.000±0.000
Alkalinity($mgCaCO_3/L$)	58.00±4.243	17.00±1.411	16.50±0.707	156.0±1.440
DO (mg/L)	2.400±0.567	3.000±0.849	1.600±0.238	2.520±0.003
BOD (mg/L)	228.0±3.112	125.28±0.396	216.88±1.245	144.51±0.495
COD (mg/L)	254.22±0.901	243.03±0.042	277.66±0.085	274.52±0.056
TSS (mg/L)	463.0±4.242	2476.1±8.344	4169.0±12.73	3176±8.485
TDS (mg/L)	345.0±7.071	140.3±0.424	320.0±2.828	275.0±0.005
Conductivity(µS/cm)	573.0±4.243	233.0±4.330	539.0±12.74	456.0±8.887
Sulphate (mg/L)	72.4±0.014	11.13±0.017	18.06±0.078	18.05±0.141
Nitrate (mg/L)	15.95±0.007	11.64±0.057	20.21±0.018	13.87±0.127
Chloride (mg/L)	56.40±0.084	26.88±0.155	19.55±0.712	82.22±0.311
Phosphate (mg/L)	4.850±0.411	5.885±0.707	6.105±0.007	4.730±0.009
Carbonate (mg/L)	193.4±22.44	10.40±0.823	9.92±0.432	93.70±9.141

S.D = Standard Deviation

Table 3: Mean concentrations of metals in the soap effluent

Metals	Week 1 (Mean ±S.D)	Week 2 (Mean ±S.D)	Week 3 (Mean ±S.D)	Week 4 (Mean ±S.D)
Sodium (mg/L)	1.229±0.001	0.922±0.007	1.114±0.009	0.633±0.011
Potassium (mg/L)	2.222±0.003	3.271±0.001	2.112±0.001	5.354±0.005
Calcium (mg/L)	1.722±0.004	1.443±0.006	1.820±0.003	5.422±0.007
Magnesium(mg/L)	2.244±0.005	2.111±0.011	2.001±0.001	2.714±0.004
Cadmium (mg/L)	0.089±0.003	0.095±0.001	0.080±0.001	0.085±0.007
Chromium (mg/L)	0.251±0.009	0.248±0.007	0.126±0.008	0.077±0.005
Copper (mg/L)	0.121±0.003	0.165±0.006	0.116±0.011	0.119±0.001
Iron (mg/L)	0.029±0.008	0.038±0.003	0.051±0.003	0.089±0.006
Manganese (mg/L)	0.080±0.009	0.072±0.005	0.066±0.008	0.069±0.002
Lead (mg/L)	0.010±0.004	0.007±0.005	0.004±0.007	0.005±0.007
Zinc (mg/L)	0.079±0.006	0.110±0.011	0.071±0.001	0.102±0.005

S.D = Standard Deviation

Table 4: Seasonal variation in physico-chemical parameters of well waters

	Well 1 (Mean ±S.D)		Well 2 (Mean ±S.D)		Well 3 (Mean ±S.D)		Well 4 (Mean ±S.D)		Well 5 (Mean ±S.D)		Well 6 (Mean ±S.D)		Well 7 (Mean ±S.D)		ANOVA	
Parameters	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	F	P
Water Temp ^{o}C	22.50 ±0.707	24.50 ±0.707	25.25 ±0.354	26.00 ±0.000	22.50 ±0.707	24.25 ±0.354	26.00 ±0.000	26.50 ±0.707	24.00 ±0.00	26.50 ±0.000	25.75 ±0.354	26.75 ±0.354	26.00 ±0.000	24.25 ±1.061	2.772	0.108
Apparent Colour (Pt.Co)	107.95 ±0.000	11.99 ±0.000	91.96 ±113.1	21.99 ±31.09	395.83 ±316.6	53.98 ±76.33	603.75 ±203.6	587.75 ±135.7	757.18 ±167.5	1803.3 ±0.000	507.78 ±158.3	363.85 ±90.47	395.84 ±226.2	43.98 ±45.23	0.446	0.510
Turbidity (NTU)	10.17 ±4.617	5.270 ±2.312	11.80 ±2.305	0.190 ±0.262	18.34 ±16.17	2.000 ±2.305	36.30 ±0.000	82.04 ±4.617	55.91 ±9.241	153.91 ±0.000	34.67 ±16.17	10.17 ±0.000	19.97 ±23.10	3.450 ±4.879	0.005	0.944
pH	8.150 ±0.071	8.400 ±0.283	6.180 ±0.035	6.380 ±0.177	8.650 ±0.354	7.130 ±1.378	10.30 ±0.141	10.05 ±0.212	9.500 ±0.276	8.700 ±0.000	9.350 ±0.071	9.150 ±0.354	6.640 ±0.198	6.160 ±0.057	1.198	0.284
Acidity ($mgCaCO_3/L$)	20.00 ±2.828	31.00 ±21.21	41.00 ±1.414	47.50 ±6.370	17.00 ±1.414	53.00 ±5.66	30.00 ±2.828	53.75 ±8.84	49.00 ±1.414	82.00 ±0.000	57.00 ±1.414	78.00 ±9.89	59.30 ±0.989	80.00 ±25.46	7.547	0.011
Alkalinity ($mgCaCO_3/L$)	67.60 ±7.071	86.50 ±27.57	33.63 ±1.464	32.05 ±2.120	71.00 ±1.414	54.50 ±17.67	544.00 ±16.97	684.50 ±120.9	242.00 ±5.656	251.33 ±0.00	239.00 ±4.242	300.5 ±44.55	42.30 ±0.424	41.00 ±1.410	0.111	0.742
DO (mg/L)	4.290 ±0.049	3.670 ±0.09	4.260 ±0.367	2.400 ±0.96	4.710 ±0.049	4.100 ±2.400	3.000 ±0.283	0.000 ±0.000	2.600 ±0.283	0.000 ±0.000	0.600 ±0.283	0.000 ±0.000	4.470 ±0.473	2.520 ±1.52	5.104	0.033
BOD (mg/L)	48.32 ±4.419	38.64 ±10.66	47.34 ±3.288	39.03 ±9.899	54.98 ±7.538	43.65 ±11.97	55.67 ±7.976	44.35 ±11.78	50.54 ±5.324	48.04 ±0.000	58.18 ±8.817	47.86 ±8.103	57.72 ±8.916	46.54 ±9.029	11.09	0.003
COD (mg/L)	24.57 ±2.058	23.90 ±4.536	23.11 ±1.433	23.83 ±4.523	26.67 ±2.006	25.96 ±4.927	26.48 ±2.159	25.29 ±4.799	28.49 ±3.690	30.42 ±0.000	30.28 ±4.488	30.92 ±5.868	32.08 ±5.697	32.48 ±6.165	0.001	0.972
TSS (mg/L)	85.40 ±10.47	78.30 ±2.545	51.40 ±0.565	72.30 ±11.45	89.70 ±24.75	50.45 ±37.27	201.5 ±28.99	375.5 ±55.86	178.0 ±7.071	237.0 ±0.000	82.30 ±10.32	95.50 ±53.03	103.1 ±21.07	81.70 ±14.42	0.359	0.554
TDS (mg/L)	61.60 ±4.808	87.70 ±9.617	75.10 ±14.28	43.70 ±8.343	85.30 ±0.707	71.55 ±30.62	660.5 ±41.72	782.5 ±38.89	319.5 ±6.364	333.0 ±0.000	314.70 ±14.57	354.5 ±10.60	63.55 ±2.475	55.30 ±4.525	0.024	0.878
Conductivity (µS/cm)	88.15 ±6.858	146.70 ±16.97	124.90 ±23.76	72.75 ±14.07	142.65 ±1.202	119.40 ±51.19	1102.0 ±69.29	1307.0 ±63.63	532.50 ±10.61	555.0 ±0.000	524.0 ±24.04	589.50 ±14.84	108.93 ±7.962	92.35 ±6.858	0.028	0.869

S.D = Standard Deviation

Table 5: Seasonal variation in anion concentrations in well waters

	Well 1 (Mean ±S.D)		Well 2 (Mean ±S.D)		Well 3 (Mean ±S.D)		Well 4 (Mean ±S.D)		Well 5 (Mean ±S.D)		Well 6 (Mean ±S.D)		Well 7 (Mean ±S.D)		ANOVA	
Anions	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	F	P
Sulphate (mg/L)	34.35 ±1.626	31.67 ±0.785	12.52 ±1.138	13.49 ±1.456	14.71 ±0.847	12.73 ±0.849	51.85 ±1.909	53.95 ±2.192	70.56 ±14.07	76.37 ±0.000	77.19 ±2.390	78.87 ±1.633	61.94 ±1.966	70.44 ±2.913	2.053	0.164
Nitrate (mg/L)	0.669 ±0.017	0.315 ±0.049	0.705 ±0.004	0.428 ±0.045	1.158 ±0.065	0.730 ±0.071	1.391 ±0.509	1.212 ±0.337	1.557 ±0.609	1.089 ±0.000	0.916 ±0.055	0.751 ±0.339	0.768 ±0.004	0.315 ±0.049	2.189	0.151
Chloride (mg/L)	92.08 ±18.99	79.51 ±14.29	38.37 ±8.676	25.05 ±2.609	83.43 ±7.177	74.85 ±15.66	276.25 ±33.16	264.15 ±73.03	197.15 ±7.566	181.90 ±0.000	231.05 ±27.51	204.0 ±20.93	133.03 ±2.793	130.45 ±39.95	3.975	0.051
Phosphate (mg/L)	4.510 ±0.067	3.430 ±0.968	4.690 ±0.180	3.761 ±1.064	4.340 ±0.562	4.077 ±1.078	4.430 ±0.526	4.126 ±1.166	6.030 ±0.350	4.990 ±0.000	7.080 ±1.326	6.516 ±2.736	5.209 ±0.965	4.938 ±1.866	1.708	0.203
Carbonate (mg/L)	40.56 ±4.242	51.90 ±16.55	20.18 ±0.878	19.50 ±1.273	42.60 ±0.848	32.70 ±10.61	326.40 ±10.18	410.70 ±72.54	145.20 ±3.394	150.80 ±0.000	143.40 ±2.545	180.30 ±26.73	25.38 ±0.254	24.60 ±0.848	0.111	0.742

S.D = Standard Deviation

Table 6: Seasonal variation in metal concentrations in well waters

	Well 1 (Mean ±S.D)		Well 2 (Mean ±S.D)		Well 3 (Mean ±S.D)		Well 4 (Mean ±S.D)		Well 5 (Mean ±S.D)		Well 6 (Mean ±S.D)		Well 7 (Mean ±S.D)		ANOVA	
Metals	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	F	P
Sodium (mg/L)	16.22 ±4.405	8.840 ±1.583	11.50 ±2.418	5.935 ±1.053	13.71 ±3.528	7.970 ±1.357	5.905 ±3.613	2.710 ±1.032	21.79 ±3.818	12.05 ±0.000	19.18 ±4.285	10.19 ±1.880	24.79 ±6.668	11.39 ±2.800	14.22	0.001
Potassium (mg/L)	4.328 ±0.683	1.589 ±0.204	5.009 ±1.404	2.265 ±0.388	3.433 ±0.787	1.458 ±0.325	8.261 ±1.315	3.477 ±0.706	3.889 ±0.322	1.903 ±0.00	5.497 ±1.039	2.553 ±0.616	5.262 ±1.372	2.235 ±0.412	30.89	0.000
Calcium (mg/L)	18.53 ±0.796	12.29 ±3.012	14.59 ±2.608	10.77 ±1.407	17.69 ±1.999	14.57 ±3.471	7.034 ±3.318	3.883 ±0.418	31.94 ±6.014	21.88 ±0.000	16.20 ±2.790	10.49 ±1.245	24.68 ±9.673	13.78 ±3.493	4.028	0.056
Magnesium (mg/L)	5.044 ±2.641	1.663 ±0.297	4.045 ±1.828	1.508 ±0.278	3.916 ±1.673	1.497 ±0.289	4.571 ±2.471	1.883 ±0.318	5.615 ±2.894	2.411 ±0.000	1.880 ±1.458	0.753 ±0.129	5.848 ±2.913	2.416 ±0.698	19.69	0.000
Cadmium (mg/L)	0.082 ±0.008	0.061 ±0.001	0.087 ±0.005	0.068 ±0.002	0.070 ±0.006	0.050 ±0.004	0.076 ±0.008	0.040 ±0.013	0.058 ±0.006	0.043 ±0.001	0.071 ±0.007	0.059 ±0.002	0.164 ±0.052	0.079 ±0.013	6.562	0.017
Chromium (mg/L)	0.156 ±0.022	0.166 ±0.032	0.132 ±0.039	0.154 ±0.025	0.175 ±0.027	0.092 ±0.006	0.245 ±0.035	0.055 ±0.012	0.253 ±0.040	0.022 ±0.001	0.221 ±0.013	0.017 ±0.004	0.211 ±0.004	0.014 ±0.006	30.72	0.000
Copper (mg/L)	0.098 ±0.002	0.096 ±0.011	0.101 ±0.003	0.105 ±0.018	0.091 ±0.018	0.085 ±0.015	0.107 ±0.031	0.088 ±0.016	0.136 ±0.065	0.098 ±0.001	0.135 ±0.062	0.084 ±0.016	0.134 ±0.063	0.081 ±0.016	4.464	0.045
Iron (mg/L)	0.063 ±0.057	0.016 ±0.003	0.059 ±0.048	0.032 ±0.004	0.033 ±0.001	0.039 ±0.006	0.035 ±0.004	0.057 ±0.016	0.141 ±0.130	0.088 ±0.001	0.035 ±0.022	0.079 ±0.019	0.089 ±0.040	0.093 ±0.028	0.287	0.597
Manganese (mg/L)	0.073 ±0.012	0.046 ±0.012	0.079 ±0.013	0.044 ±0.009	0.057 ±0.009	0.039 ±0.011	0.061 ±0.008	0.032 ±0.009	0.098 ±0.008	0.037 ±0.001	0.057 ±0.006	0.022 ±0.004	0.087 ±0.008	0.025 ±0.006	48.72	0.000
Lead (mg/L)	0.075 ±0.015	0.006 ±0.001	0.028 ±0.035	0.005 ±0.001	0.109 ±0.068	0.002 ±0.001	0.149 ±0.054	0.005 ±0.002	0.025 ±0.033	0.005 ±0.001	0.005 ±0.005	0.003 ±0.001	0.102 ±0.045	0.003 ±0.003	13.06	0.001
Zinc (mg/L)	0.145 ±0.014	0.049 ±0.008	0.289 ±0.019	0.064 ±0.020	0.138 ±0.013	0.044 ±0.008	0.202 ±0.044	0.068 ±0.021	0.157 ±0.008	0.071 ±0.001	0.167 ±0.013	0.084 ±0.016	0.189 ±0.030	0.081 ±0.016	68.15	0.000

S.D = Standard Deviation

Table 7: World Health Organisation Standards and National Environmental Standards and Enforcement Agency for Chemicals, Pharmaceutical, Soap and Detergent Industries

Parameters	W.H.O (2008), for Drinking Water	NESREA 2008, for Effluent
Temperature (^oC)	40^oC	Ambient
Apparent Colour (Pt.-Co.)	Colourless	Colourless
Turbidity (NTU)	5 NTU	NA
pH	6.5 – 9.2	6 – 9
Acidity ($mgCaCO_3/L$)		
Alkalinity ($mgCaCO_3/L$)		
Dissolved Oxygen (mg/L)	3	3
Biochemical oxygen demand (mg/L)	50	20
Chemical oxygen demand (mg/L)	10	40
Total suspended solids (mg/L)	5	10
Total dissolved solids (mg/L)	500	500
Conductivity (µS/cm)	1000	1000
Nitrate (mg/L)	45	10
Chloride (mg/L)	200-600	100
Sulphate (mg/L)	200-400	100
Carbonate (mg/L)	-	-
Phosphate (mg/L)	5.0	2
Sodium (mg/L)	200	200
Potassium (mg/L)	10	NA
Calcium (mg/L)	75	NA
Magnesium (mg/L)	50	NA
Cadmium (mg/L)	0.05	0.1
Chromium (mg/L)	0.05	0.01
Copper (mg/L)	1.0	1
Iron (mg/L)	0.3	2
Manganese (mg/L)	0.1	1
Lead (mg/L)	0.05	0.1
Zinc (mg/L)	5.0	5.0

NA = Not Available

DISCUSSION

- Apparent colour, turbidity, pH, BOD, COD and TSS mean values in soap effluent samples (Table 2) were above NESREA limits, (Table 7), while alkalinity, phosphate, TDS and conductivity mean values were above the standards in some soap effluent sampled; other physico-chemical parameters were below the said standards.

- Mean concentrations of all the metals including heavy metals for soap effluent samples (Table 3) were below NESREA limits (Table 7) except cadmium and chromium whose concentrations are higher than the standard safe limits.

DISCUSSION

- Sources of pollution from the industries could be associated with raw materials, production processes and stages, process pipework and pump, effluent pipework, tanks and waste storage. Also effluent discharged volume and concentration, cleaning process in the industries could be associated with pollution in the effluent.

DISCUSSION

- The mean values of physico-chemical parameters in well water samples collected in all the study area for both seasons in this study revealed a generally higher mean values in the wet season more than in the dry season, Tables 4 and 5.

- Continuing effluent discharges aided by heavy precipitation during wet season increase the release and infiltration of percolation of pollutants into some wells located closely to effluent drainage selected for this study, hence, high concentrations of the parameters in the wet season, Table 6.

DISCUSSION

- The mean physico-chemical parameters of well water in both seasons were not significantly different at $P>0.05$ except acidity, DO and BOD (Table 4).

- Also mean concentrations of anions in both seasons were not significantly different at $P>0.05$ (Table 5).

- Mean concentrations of metals in both seasons were significantly different at $P<0.05$ except calcium and iron. (Table 6).

- BOD, COD, TDS, TSS and conductivity, apparent colour, turbidity, pH, alkalinity, phosphate and chloride, lead, chromium and cadmium mean values exceeded the safe limits of W.H.O., 2008 in some wells (well 4, well 5 and well 6 in most cases).

CONCLUSION

- Continue discharge of untreated effluent from a Medicated Soap industry into the open drainage have resulted over the years into pollution of groundwater located around the effluent's drainage.

- This study concludes that there is need to treat the wastewater from the Soap industry before being discharged. Also the method of discharge should be according to standards.

THANK YOU FOR LISTENING