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WATER QUALITY OF SHALLOW WELLS LOCATED CLOSE TO DUMP SITES IN AKURE, NIGERIA

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The quality of waters from eight wells located within 100 meters of dump sites in Akure, the capital of Ondo State, Nigeria was investigated.Several physico-chmical parameters that include temperature, pH, conductivity, total dissolved solute, total suspended solid, total alkalinity, total hardness; The concentration of phenols and the anions: Cl^-, NO_3^- SO_4^{2-} and PO_4^{3-}; and those of the following metals: Na, K, Ca,Mg, Fe, Mn, Co, Ni, Cr, Cd, Hg, Cu and pb were determined using standard analytical methods. Bacteriological studies involving total plate count and the MPN index were also carried out. Large variations among wells were observed for most of the parameters. They also showed seasonal variation. Although microbial counts were relatively high for some of the water samples, the presence of *Escherichia coli* was not detected. Compared with WHO recommended standards the overall data suggest that most of the wells are polluted and their waters require some treatment to make them suitable for domestic use. The need for scientific methods of municipal waste disposal and for improved constructionof wells are advocated.

Key words: Water quality, Shallow wells, Dump site.

Introduction

The issue of environemtal pollution has become a major problem in many Nigerian cities. Unlike what happens in many developed countries where industrialisation is the major source of environmental pollution, many Nigerian cities are polluted as a result of inadequate facilities such as housing, treated water and efficient means of waste disposal.The World Bank [1] has observed that the environmental problem of Nigeria has led among others to soil degradation, water contamination and air pollution which when quantified in monetary temrs have resulted in losses estimated to be as high as five billion US dollars per annum.

In order to control this dangerous situation, the Federal Government of Nigeria in 1988 set up a Federal Environmental Protection Agency (FEPA) which is charged with the responsibility to monitor and control the state of the Nigerian environment and to establish environmental quality standards. The Federal Government also introduced sanitation programmes whereby genral cleaning is carried out in towns and villages on the last Staurday of every month. Noble as these steps are, there are some obvious shortcomings that millitate against the full realisation of the objectives. Take Akure for example, most of the refuse generated are desposited at uncontrolled dump-sites.

As a result of inadequate treated municipal water supply, many inhabitants within Akure depend on wells as their major source of water supply for their domestic needs. Since the water table in many parts of Akure is low [2], many of the wells are shallow not exceeding 1.5-6m deep and are sometimes located close to dump sites. Water is usually drawn from the wells by attaching a string to a plastic or metal container. Apart from the dump sites constituting public nuisance due to their repulsive sight and offensive odour, the nearby soils and wells stand the risk of contamination during tropical heavy rainfall through natural run-off of materials seeping from the dump sites.

The quality of water from eight shallow wells located within 100 meters to dump sites has been investigated in order to access the level of pollution of the wells to which the dump sites could be major contributors. The results are discussed in this paper.

Experimental

Sampling. Water samples were taken from eight wells at different locations within Akure. Sampling was carried out in the middle of dry season (Jan. 1991) and rainy season (July, 1991). Grab samples were taken with 2-litre wide mouthed glass bottles which has been previously leached with 1:1 HCl. The samples were then put in plastic bottles and preserved in a deep freezer at 2° pending analysis. The samples for bacteriological analysis were collected in 250cm^3 sterile pyrex bottles with ground stoppers and immediately immersed in a plastic bucket containing ice blocks.

Analysis. Temperature was taken in situ while pH, conductivity, alkalinity, suspended solids and total dissolved solids were determind immediately on arrival at the laboratory. Bacteriological examinations involving total plate count (nutrient agar) and MPN (Mac Conkey broth) were carried out within 3 hrs of sample collection. pH was determined with a Kent EIL 7020 pH-meter and conductivity with TSI model 33 5-C-T meter.

Various standard methods [3] were used for other parameters. Total dissolved solid - gravimetry after filtering 100 cm^3 sample through a weighed filter paper (Whatman GF/C) followed by evaporation and ignition; total suspended solids - gravimetry after filteration and drying for 1 hr in an oven (GallenKamp, 300 plus series) at 105°; total hardness - EDTA titration using Erichrome Black T indicator; total alkalinity - acidimetry using bromocresol green-methyl red mixed indicator; chloride-Mohr's methods; nitrate - colorimetry phenol disulphonic acid; sulphate - barium sulphate turbidimetry; phosphate - molybdate methods; Phenols-colorimetry using the chloroform extract of the 4, aminoantipyrine complex.

Sodium and potassium were determined by flame photometry (corning, model 405); iron, manganese, copper, cobalt, nickel, chromium and cadmium by Atomic Absorption spectrophotometry (Pye Unicon SP9) using air-acetylene flame; calcium and magnesium by EDTA titration; while mercury was by colorimetry (Corning colorimeter 253) using the chloroform extract of mercury dithizonate.

Results and Discussion

Tabale 1 gives the average seasonal values of some physico- chemical data for water samples from the eight selected wells while the avarage values for individual samples are shown in Table 2. The mean temperature for both seasons are slightly higher than the average ambient temperature of 25.89±1.22°. The temperature ranges of 2.5° and 2.2° obtained for the dry and rainy seasons respectively might be accounted for by the fact that some wells were properly covered with concrete headwall while some hadwooden covers with several cracks through which air could circulate. Hence some waters as for samples 7 and 8 had temperatures closer to the ambient temperature.

There is little variation in pH from well to well and between seasons. On the average, pH values are slightly lower during the rainy season. This might be due to the presence of acidic effluents which permeat into the wells. Sample 8 for example is close to a dump site along the General hospital road where wastes from pharmaceutical shops are dumped, while sample 3 is from Araromi Street where the dump site is known for its organic wastes mainly from bush clearing and farm produce. The area also sufers from serious floading duringd the rainy season as a result of lack of proper drainage system. Except for waters from wells 6 and 7, others have pH below WHO [4] range of 7.0-8.5. Interestingly water samples from wells 3 and 8 show sharp sour taste which the users claimed had been associated with the wells since they were drilled. One is therefore inclined to suggest metal hydrolysis as a possible factor affecting the pH. While few households use plastic storage vessels, the local clay pots and metal pails are dominant. Low pH water is capable of corroding metal containers and may leach mud pots to increase ion concetrations above permissible levels.

TDS and TSS are lower for dry season than rainy season, thus indicating the presence of debris associated with run off during the rainy season. There is more variation among TDS values than TSS. The differences in the chemical charcteristics of the water smaples, e.g. acidity, could affect solute solubilities. The hardness of the well waters is on the average on the high side. This could affect their domestic use as hard water wastes soap and is capable of depositing scale[5], scales impede heat and mass transfer processes especially in pipes and also increase the cost of cleaning.

The Concentration of the anions: Cl^-, NO_3^-, SO_4^{2-} and PO_4^{3-} are relatively high. Except for Cl^- there is little variation between seasons. The presence of PO_4^{36} and SO_4^{2-} might have been enhanced by routine laundring and washing of dinning utensils around some of the wells. Five out of the eight wells

TABLE 1. SUMMARY OF AVERAGE DATA FOR SEASONAL ANALYSIS OF WELL WATERS.

Temp. (°C)	DS	RS
	27.3 ±1.0	27.2 ± 0.9
	26.0 - 28.5)	(26.0 - 28.2)
pH	6.8 ± 0.5	6.7 ± 0.7
	(6.0 - 7.4)	(5.7 - 7.9)
Conductivity	209.50 ± 127.12	503.70 ± 274.15
(umhos/cm)	(105.6 - 508.2)	(200.6 - 810.5)
TDS (mg/1)	281.02 ± 234.24	300.92 ± 231± 231.78
	(93.25 - 791.20)	124.52 - 811.25)
TSS (mg/1)	14.85 ± 3.10	27.24 ± 2.16
	(10.60 - 18.10)	(24.15 - 30.12)
Total alkalinity	4.21 ± 4.41	5.86 ± 6.84
(mg/1)	(0.56 - 12.30)	(0.92 - 20.05)
Total hardness	195.01 ± 153.60	214.30 ± 180.04
(mg/1)	(73.05 - 480.42)	(71.50- 548.12)
Cl^- (mg/1)	91.41 ± 74.69	110.18 ± 90.75
	(26.05 - 237.05)	(34.04 - 265.65)
NO_3^- (mg/1)	2.25 ± 0.71	2.21 ± 0.71
	(1.32 - 3.42)	(1.42 - 3.52)
SO_4^{2-} (mg/1)	3.42 ± 1.84	3.72 ± 1.14
	(0.82 - 6.20)	(2.40 - 5.45)
PO_4^{3-} (mg/1)	1.12 ± 0.43	1.02 ± 0.20
	(0.74 - 2.08)	(0.75 - 1.34)
Phenols* (mg/l)	0.08 ± 0.02	0.08 ± 0.04
	(nd - 0.01)	(nd - 0.12)

Values are mean ± SD, ranges are in parenthesis Alkalinity and total hardness as Ca CO_3, DS - dry season; RS - rainy season; TDS - Total dissolved solid; TSS - total suspended solid, mean ambient temp = 25.89 ± 1.22°C. 10^{-2}.

have detectable levels of phenols, the concentrations of which appear to be higher during the rainy season. The phenols were probably washed from residual organic chemicals thrown on dump sites. Although the levels of phenols are within WHO permissible level [4] their presence in drinking water is unacceptable as they tend to impact taste and odour.

Table 3 gives a summary of the metal concentrations in the well waters. The metals are widely distributed except Co, Cd, Cu, Hg, and Pb. Cadmium and mercury were not detected in any of the water samples. This is a welcome relief as the two metals are toxic to human beings even at low concentrations [6,7] cobalt was detected in sample 4 only while Pb and Cu were found in two samples each. Na, K, Ca, and Mg are particularly relatively abundant while nickel and chromium unlike cobalt are widely distributed in low concentrations. Some of the nickel concentrations however, are already above

TABLE 2: PHYSICO-CHEMICAL DATA OF WELL WATERS.

Sample	Temp (°C)		PH		TDS (mg/1)		TSS (mg/1)		Alkalinity (mg/1)		Total hardness (Mg/1)	
	DS	RS	DS	RS	DS	RS	DS	RS	DS	RS	DS	RS
1.	28.0	28.2	6.6	7.9	93.25	131.20	16.00	27.70	1.74	2.18	89.02	103.42
2.	28.5	28.1	6.6	6.4	150.10	196.25	11.70	27.82	1.10	1.32	73.05	71.50
3.	28.0	27.4	6.0	6.2	191.30	201.05	18.10	25.05	1.71	1.15	100.00	91.10
4.	26.1	28.0	6.8	6.5	448.02	451.22	11.30	29.40	2.70	3.14	180.10	194.20
5.	27.4	26.0	7.1	6.8	791.20	811.25	17.50	24.15	9.91	12.00	383.40	548.12
6.	28.0	27.2	7.2	7.0	269.30	301.25	16.72	30.12	3.64	6.13	169.52	178.20
7.	26.0	26.5	7.4	7.1	118.60	124.52	16.90	28.32	12.30	20.05	480.42	438.51
8.	26.4	26.0	6.3	5.7	186.40	190.61	10.60	25.35	0.56	0.92	84.56	89.32

Sample No.	C1– (mg/1)		NO_3^- (mg/1)		SO_4^{2-} (mg/1)		PO_4^{3-} (mg/1)		Conductivity (umhos/cm)		Phenols (mg/1)	
	DS	RS	DS	RS	DS	RS	DS	RS	DS	RS	DS	RS
1.	26.05	34.04	1.83	1.75	0.82	2.40	0.95	1.12	160.5	210.9	nd	0.01
2	32.00	35.04	1.32	1.42	1.40	2.62	0.85	0.80	180.2	490.3	nd	nd
3.	39.10	45.20	1.64	1.60	2.45	2.68	0.82	0.94	220.2	805.4	0.10	0.11
4.	144.60	122.06	2.88	2.34	3.00	3.40	1.04	0.97	508.2	810.5	0.05	0.07
5.	131.05	232.05	2.43	2.14	6.20	5.45	0.74	0.75	105.6	230.8	nd	nd
6.	38.21	65.02	2.64	2.92	4.70	3.88	1.22	1.34	220.8	800.6	0.80	0.07
7.	237.05	265.65	3.42	3.52	4.91	4.98	1.28	1.21	140.3	200.6	0.06	0.08
8.	83.25	82.35	1.80	2.00	3.92	4.32	2.08	1.02	140.2	480.4	0.10	0.12

*Values x10^{-2}.

TABLE 3. METAL CONCENTRATIONS (mg/1) IN WELL WATERS.

Sample No.	Na	K	Ca	Mg	Mn	Co	Ni	Cd	Fe	Cu	Pb	Hg(g/1)	Cr(g/1)
1.	25.00	7.52	11.03	3.25	nd	nd	0.32	nd	0.42	nd	0.02	nd	0.20
2.	20.55	4.25	12.45	5.28	nd	nd	0.09	nd	0.25	0.005	nd	nd	0.06
3.	20.60	5.22	26.10	7.32	nd	nd	0.01	nd	0.45	nd	nd	nd	0.14
4.	73.65	19.65	24.81	4.52	0.02	0.01	nd	nd	1.12	0.002	nd	nd	0.09
5.	140.52	50.22	80.75	22.52	nd	nd	nd	nd	0.14	nd	nd	nd	0.37
6.	61.10	16.50	54.25	10.02	0.10	nd	0.21	nd	0.83	nd	0.52	nd	0.42
7.	120.30	43.31	71.31	30.52	0.20	nd	0.05	nd	40.22	nd	nd	nd	0.22
8.	35.33	5.25	10.55	8.65	nd	nd	0.22	nd	0.22	nd	nd	nd	0.16
Overall	62.192	19.22	36.36	11.51	-		0.11	-	1.02		-	-	0.21
Mean±SD	±	±	±	±	–	±	±						±
	46.62	18.54	28.41	9.75	–	–	0.12	1.33					0.13

nd - not detected.

the WHO [4] permissible level as nickel is very toxin especially in form of its carbonyls [5]. The presence of appreciable concentrations of Mg and Ca is consistent with the level of hardness observed. Sodium and potassium concentrations are probably high because of the high solubility of their salts and as a result of laundry activities around some of the wells. High level of sodium is known to have adverse effects on people with cardiace, renal or circulatory problems [8].

The iron levels are generally high and above the WHO permissible level of 0.05mg/1 [4]. High iron concentration imparts taste and colour to water. It also encourages the formation of scales and slimes [7]. The level of Fe in sample 4 calls for serious concern. Further investigation suggested two possible sources of iron enrichment. The well is used by several neighbouring households with different metal pails for drawing water from the well. The dump site located 40 meters away from the well was observed to contain many metal scraps that might originate from a nearby mechanic workshop. The reason for the high and apparently dangerous level of lead in sample 8 could not be ascertained. Lead being a cumulative poison without any known beneficial biochemical property [9,10], its presence renders the water from well 8 unsuitable for human consumption. Apart from the dumpsite located about 50 meters from the well, the nearest workshop for battery repair and recharging is located over two kilometers away from the well and might not be the source of lead. The soil on which the well is dug might therefore contain some lead minerals.

The plate counts for the number of colonies growing on nutrient agar were relatively high Table 4. The microbial load might be due to the shallow depths of the wells resulting in inefficient underground filterations of any surface waters that might permeate into the wells. Although coliform counts were lower than the total plate counts, the WHO [4] recommendation is total absence. However, the water samples all tested negative to the confirmed test for the presence of *E. coli*, thus suggesting that the coliform counts were not likely to be as a result of faecal contamination.

Okoye and Adeleke [2] have reported on the quality of waters from some randomly chosen well in a section of Akure town. Their results indicated that most of the water samples were generally less polluted than those reported in this work. The physico- chemical data suggest that the quality of the waters from the wells located close to dumpsites is doubtful. Since well waters do not flow, some of the toxin ions might build up with time and become dangerous to human health.

In order to derive more benefit from the environmental protection programme of the Federal Governement of Nigeria there is the need to discourage indiscriminate refuse dumping. Efficient incinerators are required for flammable refuse and well designed land fills for others. While every effort should be made to make treated water sufficiently avilable in every house, the present very bad position of the Nigeran economy suggestes that well waters might still be with us for al long time. It is therefore suggested that these wells be more protected form their environment. They should be make deeper, internally ringed with concrete culverts and the headwells be built of concrete and rasied at least two meters above the ground level. Plastic buckets should preferably be used to draw water from the wells while the use of wooden and cheap iron covers should give way to steel covers.

TABLE 4. BACTERIOLOGICAL DATA FOR WELL WATERS.

Sample No.	Average Seasonal (Total plate count/100 ml)	Average seasonal (MPN/100 ml)
1.	500±100	98±10
2.	4,000±500	120±25
3.	250±50	35±18
4.	800±100	240±20
5.	4,500±150	50±15
6.	3,000±200	58±5
7.	1,500±140	125±10
8.	1,000±450	138±12

Data are mean ± standard deviation.

TABLE 5. WHO GUIDELINES FOR DRINKING WATER [4].

Parameters	Recommended levels
pH	0.5 - 8.5
Hardness (calcium carbonate)	500
Cl^-	2.5
NO_3-(Nitrogen)	1.0
SO_4^{2-}	200
PO_4^{3-}	0.4
Phenol	0.001
TDS	500
Coliform	Absent in 100ml of water sample
Na	200
Ca	75
Mg	30
Mn	0.1
Ni	0.005
Fe	0.05
Fe	0.05
Cu	0.1
Pb	0.05
Hg	0.001
Cr	0.05

Values are mg/1.

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