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Baseline Concentration of Morbid Leachate In Well Water In Ankpa, Kogi State, Nigeria

Abiola K. A.[1*], Medugu N. I.[1], Ekanade, O.[2], Opaluwa, O.D.[3] Omale, L.[1] A.B. Mohammed[4]

[1]Department of Geography, Nasarawa State University, Keffi, Nasarawa State
[2]Dept of Geography, Obafemi Awolowo University, Ile-Ife, Nigeria
[3]Department of Chemistry, Nasarawa State University, Keffi, Nasarawa State
[4]Department of Geography, Modibbo Adama University of Technology, Yola, Adamawa state

Abstract

Water is abundant natural resources which is critical for the sustenance of human life. It is a well-known fact that adequate supply of fresh and clean drinking water is a basic need for all human beings on the earth. This research aimed to determine the trace of metals and other physico-chemical properties in water samples collected from eight selected location in the study area (Enjema-Ofugo) in Ankpa Local Government Area of Kogi State. The investigated metals (Na, K, Pb, Cd, Se, and Cr) were analysed using atomic absorption spectrophotometric method while Alkalinity, pH, temperature, turbidity, conductivity, total solids, total dissolved solids, suspended solids and soluble anions (phosphate, chloride, nitrate, and bicarbonate) and other physico-chemical parameters were analysed using appropriate standard techniques. The results also showed that Cd, Se and Hg were not detected, while other physico-chemical parameters were within the permissible limits set by World Health Organization (WHO) for drinking water except phosphate ion. However, source protection is recommended for the water bodies for the benefit of the community people in the study area.

Keywords: Physico-chemical properties, trace metals, under ground-water, Well Point (WP), MPN=Most Probable Number of bacteria per 100ml of sample.

INTRODUCTION

The availability of portable or safe drinking water is usually an issue of great importance in any society or community hence water is a key determinant of sustainable development including that should be carefully managed to make for suitable and sustainable human health, as well as general wellbeing (Egboh and Emeshili, 2007). The domestic use of water includes drinking, bathing, cooking and general sanitation such as laundry, flushing of closets and other household chores (Ogunawo, 2004; Anzene and Aremu, 2007). To

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collect data on the impact of morbid leachate on well water is the subject matter of this research work. The study was based at Ankpa Local Government Area of Kogi State Kogi State, Nigeria. Access to improved drinking water is widely advocated as an effective way of reducing morbidity and mortality, particularly in the poorest areas of the world and in most vulnerable population segments like children. The Enjema-Ofugo district in Ankpa Local Government Area of Kogi State Nigeria, a typical example of an area that is facing the problem of lack of good drinking water and this problem has resulted to skin infection due to the poor quality of water being consumed by the people and their domestic animals. The major source of water in the area is from hand dug wells. Unfortunately most of the hand dug wells in the communities are close to local grave or cemetery, were death people have been buried. It is believed that through leaching from these graves, well or hand dug well that are close by are impacted hence this research work aimed to find out the physic-chemical composition of such affected well water in the water sources.

MATERIALS AND METHODS

Ankpa Local Government Area of Kogi State, Nigeria is located at Latitude 7^0 22' 14N and Longitude 7 37' 34E and cover with a population of 267,353 at the 2006 census (Figure 1, 2 and 3). The language spoken by the people of Ankpa Local Government Area of Kogi State, Nigeria is Igala.

The study Area is characterised by a tropical sub-humid climate with two distinct seasons, and dry and wet season. The wet season lasts from about the beginning of April to October while the dry season is experienced between November and March. Annual rainfall figure ranges from 1100mm to about 2000mm. About 90% of the annual rainfall occurs between May and September while the wettest months are July and August. The rain comes with thunderstorm of high intensity, particularly at the beginning and towards the end of the rainy season. The months of December, January and February are cold due to the harmattan wind blowing across the Local Government Area from the North-East of Nigeria. The vegetation of the area is mainly grassland. Geographically, area forms part of the low plains of the Benue Trough which are believed to be tectonic in origin. The high land areas of the state are found toward the north, notably in Okene and Ajaokuta area. The temperature of Ankpa Local Government Area and that of Kogi State in general are high particularly from March to April. The mean monthly temperature in the state range between 20^0C and 34^0C, with the hottest months been March and April and the coolest month been December and January. The major soil unit in Ankpa Local Government Area belong to the Oxisols or tropical ferruginous (Nyagba, 1995) which contains iron hence its reddish brown colour. Lateritic occurs in extensive areas on the plains, while hydromorphic soils (humic inceptisols) occur along the flood plains of major rivers.

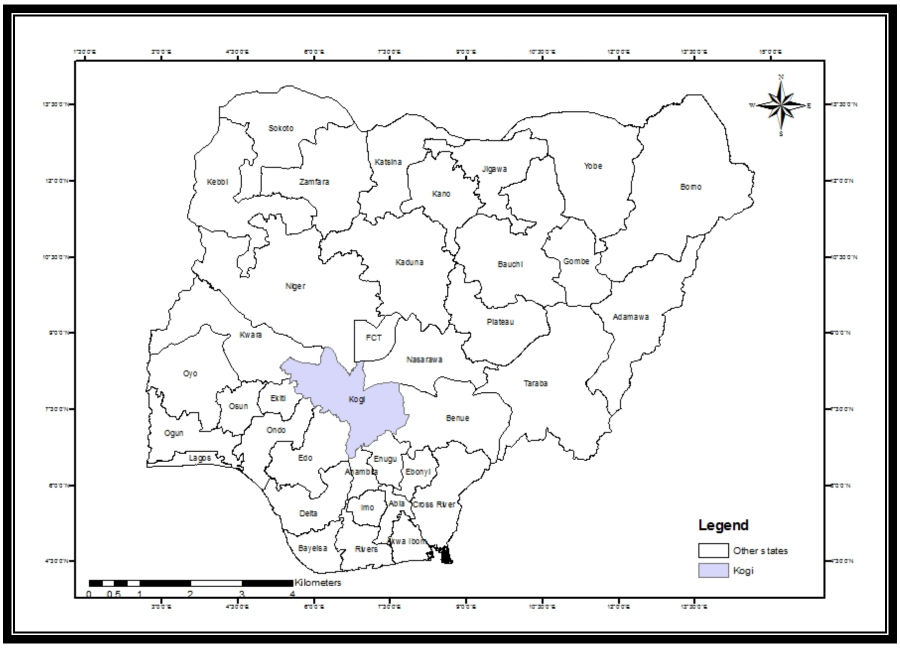

Fig: I. Map of Nigeria showing Kogi State

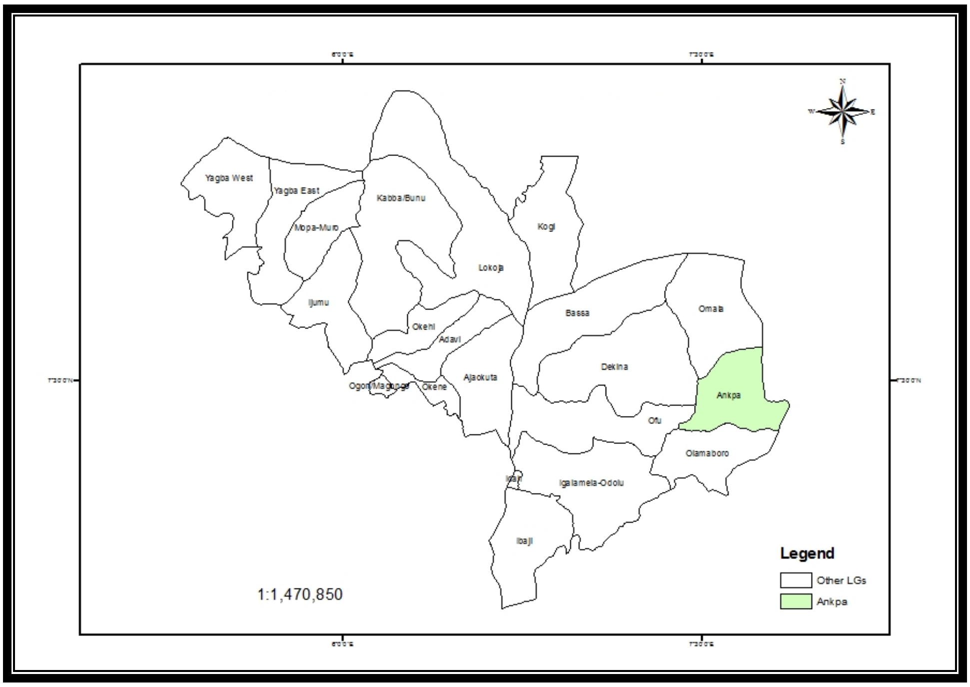

Fig. 2: Map of Kogi State Showing Ankpa Local Government Area

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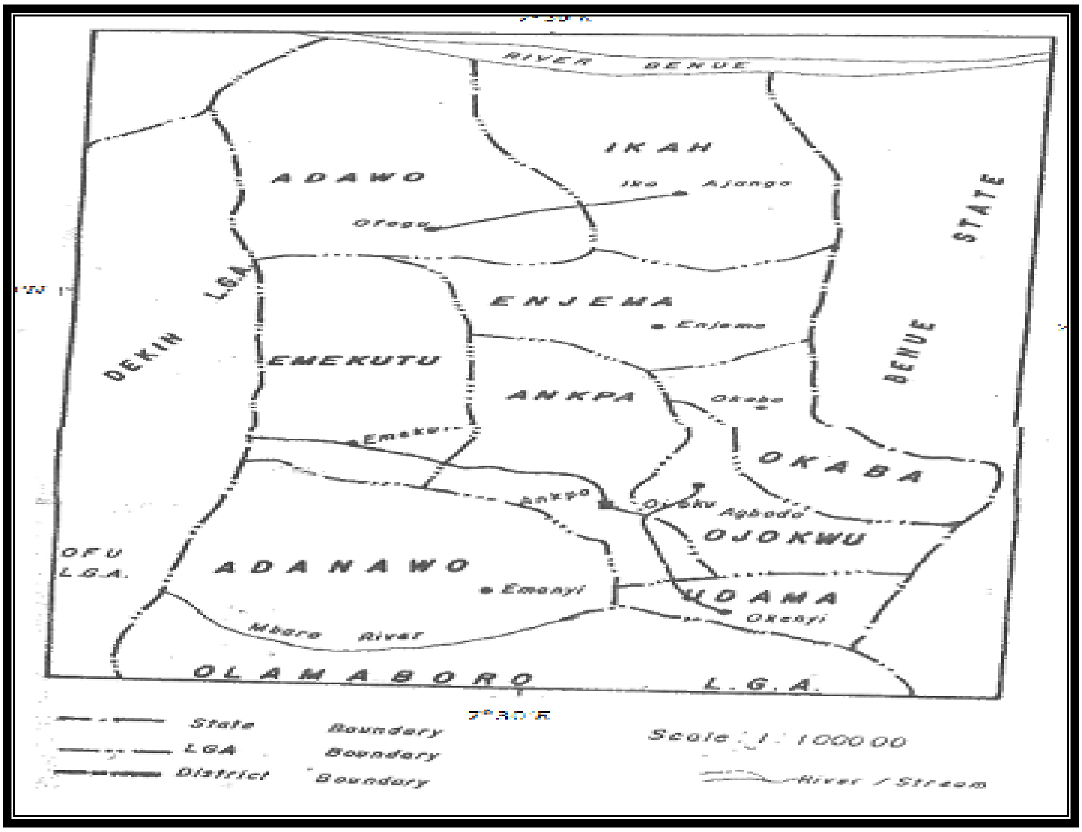

Fig: 3. Ankpa L.G.A. Showing the Districts Including Enjama District

Data Collection and Analysis

A total of sixteen samples were collected from eight communities in the area. These comprised different hand dug well samples from each community of Ankpa local government area. Samples collection spanned through the rainy (wet) seasons. The samples for the wet season were collected in May through August. The Polythene containers used for collection were washed with detergent solution, followed by several rinses with tap water and finally with distilled water (APHA, 2002). Then the containers were rinsed with the water samples to be collected. Water samples from boreholes were collected and stored in sterilized labelled polythene containers taking, appropriate precautions to prevent contamination. Sample odour was recorded using human sense of smell. The water temperatures of the well samples were determined immediately after collection using a simple thermometer calibrated in ^{O}C; Lovibond colour comparator was used for colour determination while electrical conductivity was measured with CDM83conductivity meter (by Radiometer A/S Copenhagen, Denmark) after standardization with KCl solution. The sample pH was measured with Kent EIL 7020 pH meter while Alkalinity was determined using a Buck Scientific model 200A/B Atomic Absorption Spectrophotometer (AAS) Sodium and potassium are determined using Flame Photometer (model 405) while calcium and magnesium hardness was by EDTA titration using Erichrome Black T indicator. Photometric analysis was used for phosphate, nitrite and nitrate was reduced to nitrite (ISO, 1988). Sulphate was determined by gravimetric method (ISO, 1990). Total bacterial counts of *Escherichia coli* and coliform colonies were determined using media culture incubated at $37^{O}C$ for 24hours. Total dissolved solids were determined by evaporating 100ml of water sample and then obtaining the mass of the residue formed after evaporation.

Concentrated HNO_3 ($2.5cm^3$) was added to the water samples to preserve them from metal analysis. The addition of the acid hoped in bringing up all the metals into the solution and minimised the absorption of the metals on the wall of the containers (APHA, 2002). The acid also hindered the bacterial and fungal growth in water samples before taking samples to laboratory.

The data collected were subjected to simple correlation analysis and analysis of variance (ANOVA).

Results

Table 1 below; present the result of trace metals and other element that was found in the water samples that was taken from the hand dug wells, which were taken during the dry season from the site of the study areas, from well-point 1 to 4.

The temperature of the sampling points varies from 23.4 at well-point I to 24.7 at IV, whereby III recorded temperatures of 24.7 and I and II have mean average temperature of 23.8 respectively, which falls within the mean temperature range of FEPA standard. Moreover, the mean average pH of well-point I to IV varies slightly from 4.8 to 5.8, with III recording the highest mean average PH level of 5.8 and I has the lowest pH level of 4.8 and II recorded 5.1. The three point in the area fall short below the FEPA standard of pH 6-9. However, the soil of the study site contains weak acid, due to the type of mining operating in the area. The result and present of chloride will affects any other base compound of the soil, and relatively there results will be synonymous, due to the acidic nature of the soil.

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Generally, sulphate level is low from 0.08 in well-point I to 16.9 in III, which falls short of FEPA standard of 250.

The aforementioned pH of the site is low, therefore made the soil to be of acid than base, and this however reduced the level of basic chloride in the soil, which falls short of FEPA standard (250). Moreover, chloride value ranges from 11.4 at I and 1.0 at II, III and point IV respectively. The level of the phosphate at the site of the study area varies from 0.34 at I to 0.55 at II, 0.63 at III and 0.77 at IV. All the result is lower than FEPA standard of 5, which show extend at which farming fertilizer application is at its lowest on the land, before mining activities in the area. Latisol is under the high influence of oxidation, which allows regular increase in oxidation state from ion 2 to ion 3. Therefore, Nitrate are derived from the oxidation of NH_4^+ to $N0^-$ and finally to Nitrate ($N0^-{}_3$). Therefore, the amount of Nitrate in the sample point is higher than Nitrite, due to oxidation and fall short of FEPA standard of 20, due to the leachate of the soil between the Horizons of the soil at well-point 1. The amount varies from 6.66 at well-point I, to 13.37 at II, 13.34 at III and 11.67 in IV. Tropical ferruginous soil has level of Iron, if it is under the influence of leaching and couple with mining activities. The obtainable results are synonymous with FEPA standard of 0.3. From the result, well-point I recorded 0.14, II recorded 0.32, III recorded 0.25 and 0.30 at IV. It is an ion of alkaline with high electron-positivity, but highly leached in the soil that is why potassium is found in small quantity within the soil profile. The amount of potassium element at the study area varies from 0.13 in well-point I, 8.92 in II, 8.12 in III and 6.54 in IV respectively, which is found within the range of FEPA standard of <1.

At the site, divalent ion of magnesium is very low. Sampling well-point I recorded 0.04, II recorded 0.76, III recorded 0.06 and lastly IV recorded 0.44, which fall short of FEPA standard of 100. Trace metals (Cadmium, Chromium and Cyanide, Nickel). The concentrations of these metals are very traceable which are minimum below FEPA standard.

Table 2 presents the result of trace metal and other element that was found in the water samples that was taken from the hand dug wells, which were taken during the dry season from the site of the study areas, from well-point 4 to point 7. Moreover, the mean average pH of well-point V to well-point VIII varies slightly from 7.01 to 7.09, with VI recording the highest mean average PH level of 7.09 and VIII recording the lowest mean average PH level of 7.01 and V recorded 7.04, while VII recorded 7.07. However, the soil of the study site contains weak acid, due to the type of mining operating in the area. The ionic level of the soil in the study area is very low generally, due to the mining activities, overturned impervious

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materials, to the new surface soil, increase the ion level that range between 52.6 in V and 51.2 in VIII, while at VI, it recorded 18.8 and VII has 33.7. In the study area, the salinity in various well-points where water samples were collected, from well-point V to VIII all recorded the zero values, which commensurate the FEPA standard on the degree of level of negativity ions. It is highly toxic and has been implicated in some cases of food poisoning (Aremu *et al., 2005*). Minute quantities of cadmium are suspected of being responsible for adverse changes in arteries of human kidney. The values recorded for cadmium in well-point V is 0.069, VI is 0.071, VII is 0.075 and lastly VIII is 0.091 recording the highest values in the four points.

Iron (Fe), plays an important role in the oxidation processes of respiration in living organisms (Adeyeye, 1997). It is reported to be very important for normal functioning of the central nervous system (Vyas and Chandra 1984). Tropical ferruginous soil has low level of iron, if it is under the influences of leaching and couple with mining activities. The concentration values of iron at the four points in the study area recorded 0.135 at well-point V, 0.137 at VI, 0.137 at VII, while VIII recorded 0.150 as the highest recorded.

LEAD (Pb), Lead is toxic even at low concentrations and has unknown function in biochemical processes. Sources of lead include storage batteries, cable sheaths, pigments and anti-knock compound in petrol (Crosby, 1977). The concentrations values of lead at the study area, at well-point V, it recorded 0.319, VI is 0.322, VII is 0.331, and lastly VIII recorded 0.393.

MANGANESE (Mn), majorly, manganese element is an impurity of mining metals, mostly found along mining ponds and occurs in small quantity or trace element. At well-point V, it recorded 0.130, VI record 0.138, VII record 0.161 and at VIII it recorded 0.215.

COPPER (Cu): Manganese and copper are significantly related in term of presence in the water. They are always present in small quantity in the soil, and formed a protective bound for some precious metal like Gold. The amount or concentration of copper at the study area: at well-point V 0.120, VI 0.118, VII 0.109 and VIII 0.145 and it falls within the FEPA standard of <1.

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Table 1: Water Samples from Deep Well During Wet Season

S/N	PARAMETERS	1 WELL POINT	II WELL POINT	III WELL POINT	IV WELL POINT	Mean	SD	CV	FEPA LIMIT
1	PH	4.8	5.1	5.8	5.3	5.02	2.04	40.63	6.9
2.	TEMP	23.4	23.8	24.7	24.5	24.1	8.20	34.02	≤40
3.	DO	5.0	5.0	4.0	4.7	4,17	1.89	45.32	
4.	TDS	9	10	9	9.2	9.25	2.67	28.86	500
5.	**Salinity (%)**	0	0	0	0	0	ND	ND	0.1
6.	SULPHATE	0.08	17.4	16.9	13.85	12.37	3.49	28.21	250
7.	SULPHIDE	0.03	0.09	0.05	0.05	0.05	na	Na	0.02
8.	CHLORIDE	11.4	1.0	1.0	1.0	3.10	1.06	34.19	250
9.	NITRATE	6.66	13.37	13.34	13.34	11.67	3.04	26.04	20
10.	NITRITE	0.04	0.07	0.06	0.06	0.55	0.13	23.63	10
11.	CALCIUM	34.21	34.12	34.18	34.19	34.17	17.08	50..53	150
12.	MAGNESIUM	0.04	0.76	0.06	0.32	0.44	0.02	4.54	100
13.	TOTAL HARDNESS	34.24	34.24	34.24	34.22	24.23	11.21	46.26	200
14.	PHOSPHATE	0.34	0.55	0.63	0.48	0.77	0.48	62.33	5
15.	MANGANESE	0.12	0.27	0.32	0.30	0.25	0.05	20.00	0.5
16	IRON	0.14	0.32	0.25	0,30	0.25	0.06	24.00	0.3
17	COPPER	0.27	0.36	0.42	0.34	0.35	0.097	3.39	1
18	Au	0.07	0.08	0.1	0.08	0.07	ND	ND	0.01
19	ALUMINIUM	0.05	0.06	0.06	0.05	0.05	ND	ND	0.2
20	SODIUM	0.97	0.33	0.53	0.52	0.48	0.22	52	200
21	Ni	0.02	0.03	0.03	0.03	0,03	ND	ND	<1
22	Si	ND	ND	ND	ND	ND	ND	ND	10
23	Ag	ND	ND	ND	ND	ND	ND	ND	<1
24	POTASSIUM	0.13	8.92	8.12	8.90	6.54	4.86	74.31	<1
25	BOD_5 @ 20^OC	1.6	1.9	2.3	2.1	1.97	0.41	20.81	30
26	COD	64	75.9	91.5	73.6	76.25	0.47	0.61	80
27	MPN/100ML	48	39	84	36	49.25	12.6	25.58	400
28	SALMONELLA	Present	Present	Present	Present	ND	ND	ND	‘’
29	SHIGELLA	Present	Present	Present	Present	ND	ND	ND	‘’
30.	E. COLI	Present	Present	Present	Present	ND	ND	ND	‘’

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Table 2: Water Samples from Deep Well During Wet Season

S/N	PARAMETERS (Mg/l)	V WELL POINT	VI WELL POINT	VII WELL POINT	VIII WELL POINT	Mean	SD	CV	FEPA LIMIT
1.	**Ph**	7.04	7.09	7.07	7.01	7.05	4.11	58.29	<40
2.	**TDS**	25	9	16	24	18.59	10.32	55.51	500
3.	**Salinity (%)**	0	0	0	0	0	ND	ND	0.1
4.	**Conductivity (μS/cm)**	52.6	18.8	33.7	51.2	39.07	20.1	51.44	1000
5.	**Al^{3+}**	0.046	0.044	0.044	0.055	0.045	ND	ND	<1
6.	**B**	0.088	0.083	0.094	0.115	0.095	0.062	65.26	<1
7.	**Cd^{2+}**	0.069	0.071	0.075	0.091	0.076	ND	ND	<1
8.	**Cl^{-}**	0.071	0.067	0.077	0.091	0.076	ND	ND	<1
9.	**Cr^{6+}**	0.037	0.035	0.036	0.046	0,038	ND	ND	<1
10.	**Cu^{2+}**	0.120	0.118	0.109	0.145	0.123	0.072	58.53	<1
11.	**CN^{-}**	0.026	0.026	0.026	0.029	0.026	ND	ND	<1
12.	**Au^{3+}**	0.082	0.087	0.012	0.098	0.069	ND	ND	<1
13.	**Fe^{+}**	0.135	0.137	0.137	0.150	0.139	0.077	55.39	<1
14.	**Pb^{2+}**	0.319	0.322	0.331	0.393	0.341	0.06	17.9	<1
15.	**Total Hardness**	34.24	17.12	17.12	34.24	25.68	12.95	50.42	200
16.	**Mn^{2+}**	0.130	0.138	0.161	0.215	0.161	0.084	52.17	-
17.	**Ni^{2+}**	0.135	0.127	0.158	0.236	0.164	0.073	44.51	<1
18.	**NO_3^{-}**	0.084	0.084	0.093	0.113	0.093	0.065	69.89	20
19.	**NO_2^{-}**	0.053	0.051	0.065	0.064	0.058	ND	ND	10
20.	**PO_4^{-}**	0.036	0.091	0.036	0.094	0.064	ND	ND	5
21.	**K^{+}**	0.142	0.140	0.171	0.206	0.164	0,073	44.51	1
22.	**Si**	0.048	0.048	0.047	0.052	0.048	ND	ND	<1
23.	**Ag+**	0.097	0.096	0.098	0.128	0.104	0.062	59.61	<1
24.	**SO_4^{2-}**	12.1	12.0	13.2	15.2	12.10	3.36	27.76	500
25.	**S^{2-}**	0.077	0.062	0.074	0.091	0.076	0.02	26.31	<1
26.	**Sn^{2+}**	0.046	0.046	0.047	0.062	0.050	ND	ND	<1
27.	**Zn^{2+}**	0.050	0.050	0.049	0.063	0.053	ND	ND	<1
28.	**BOD_5 @ $20^{O}C$**	1.5	3	2.75	3.5	2.687	0.56	20.84	20
29.	**COD**	81	81	102	96	90	0.92	1.02	80
30.	**MPN/100ml**	32	38	25	33	32	9.34	29.18	400

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Discussion

In line with the objective of the research the said result of the Pearson correlation in all the study location are similarly related, in which the minerals and chemical contents amount are almost the same. From Table 1 and 2, after correlation of the study area (Enjema-Ofugo), the well WP01 and WP02, the level of significant at 2-tailed 95% and 99% is .955, which is low and not significant in amount between the various wells. The chemical content between WP01 and WP0III is .955, WP01 and WP0IV is .386, WP01 and WP0V is .463, WP01 and WP0VI is .461, WP01 and WP0VII is .418 while WP01 and WP0VIII is .-024[xx]. However, the chemical content between WP01 recorded highest level with WP02 and WP03 respectively, which are .955.

However, the result of the correlation between WP0II and WP0III at 95% and 99% the water sample from the wells in the study area is 955, which is not significant and is lower than other result of the Pearson product moment correlation. The chemical content comparison between well WP0II and WP0IV is .386, WP0II and WP0V is .463, WP0II, and WP0VI is .461, WP0II and WP0VII is .418 and lastly WP0II and WP0VIII is .-024[x].

Moreover, the correlation co-efficient between WP0III and WP0IV is .272, WP0III and WP0V is .331, WP0III and WP0VI is .331, WP0III and WP0VII is .299, WP0III and WP0VIII is -089. WP0III and WP0IV, the level of significant at 2-tailed 95% and 99% is .272[**], which is not significant in amount among the wells in the study location, which could be as the result of recording of different quantity of chemical content between the two well in the study area.

Furthermore, the Pearson correlation between well WP0IV and the rest of the wells in the study area also show that the chemical and mineral content are similarly related. The correlation co-efficient between WP0IV and WP0V is .921, WP0IV and WP0VI is .995, WP0IV and WP0VII is .946, and lastly WP0IV and WP08 is .461. WP04 and WP02 recorded .272, which is the level of significant at 2-tailed 95% and 99%, which is not significant in amount between the two wells, which could also be because of different chemical and mineral content recorded from the two well in the study area.

The Pearson correlation between WP0V and the rest of the wells show similar quantity of both chemical and mineral content in the study area. The correlation co-efficient between WP0V and WP0VI is .993, WP0V and WP0VII is .995, while WP0V and WP0VIII is .120.

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This could be because of different chemical and mineral content recorded in the various wells in the study area. The level of significant at 2-tailed 95% and 99% is .331 between WP0V and WP0III, which is not significant in amount between the two wells, because of the chemical element recorded from both wells in the study area.

The correlation of the analysis between WP0VI and WP0VII is .973. The level of significant at 2-tailed 95% and 99% is .573 between WP0VI and WP0III, which is not significant in amount between the two wells, because of the chemical element recorded from both wells in the study area. Furthermore, Pearson correlation between WP0VII and the other point where water sample from wells was collected also shows similar quantity of both chemical and mineral content from the wells in the study area. The correlation between WP0VII and WP01 is .418, WP0VII and WP0II is .299, WP0VII and WP0III is .510, WP0VII and WP0IV is .995, WP0VII and WP0V is .955, .WP0VII and WP0VI is .993, WP0VII and WP0VIII is .973. The level of significant at 2-tailed 95% and 99% is 299 between WP0VII and WP0II, which is not significant in quantity between the two wells, because of the chemical element recorded from both wells in the study area.

Table 4: Pearson Correlation Analysis of the Water Samples

Site	ANOVA	WP01	WPOII	WP0III	WP0IV	WP0V	WP0VI	WP0VII	WP0VIII
WP01	Pearson Correlation	**1.000**	**.995**	**955****	**386****	**463****	**461***	**481**	**.-024****
	Sig.(2-tailed)	**.**	**000**	**.000**	**.042**	**.013**	**.014**	**.027**	**947**
	N	**28**	**28**	**28**	**28**	**28**	**28**	**28**	**28**
WPOII	Pearson Correlation		**1.00**	**.950^{XX}**	**.272^{XX}**	**.331^{XX}**	**.331^{XX}**	**.299^{X}**	**.-024***
	Sig.(2-tailed)			**000**	**000**	**.042**	**.013**	**.014**	**.027**
	N		**28**	**28**	**28**	**28**	**28**	**28**	**28**
WP0III	Pearson Correlation			**1.000**	**466***	**583****	**573****	**510****	**.-089**
	Sig.(2-tailed)				**012**	**001**	**001**	**006**	**808**
	N			**28**	**28**	**28**	**28**	**28**	**28**
WP0IV	Pearson Correlation				**1.000**	**921***	**946***	**995***	**.461***
	Sig.(2-tailed)					**000**	**000**	**000**	**154**

	N				**30**	**30**	**30**	**30**	**30**
WP0V	Pearson Correlation Sig.(2-tailed) N					**1.000** **30**	**993**** **000** **30**	**.964**** **000** **30**	**. 955x*** **724** **30**
WP0VI	Pearson Correlation Sig.(2-tailed) N						**1.000** **30**	**973**** **000** **30**	**.995**** **535** **30**
WP0VII	Pearson Correlation Sig.(2-tailed) N							**1.000** **30**	**973**** **000** **30**
WP0VIII	Pearson Correlation Sig.(2-tailed) N								**1.000** **30**

**** Correlation is significant at the 0.01 level (2-tailed)**

*** Correlation is significant at the 0.05 level (2-tailed)**

CONCLUSION

It is evident from the above analysis that issues of Baseline Concentration of Morbid Leachate in Water Sample from Well is a major problem, which is been faced by mostly the people in the rural part, especially in Africa, for example in Nigeria, the area where these investigation was done. The study has also presented data on the concentrations of some trace metals, microbes (E. Coli, Salmonella and Shigella) and physic-chemical properties of water sample from well at the study area. The result showed that the heavy metals and mostly water quality parameters examined for water samples from the different point in the study area are within the FEPA standard for drinking water.

It can also be deduced from the above result and discussion, that some of the element may form a potential source of contamination in the area; though, at the moment the water resources used by the people of Enjema-Ofugo area in Ankpa L.G.A and its environs may be regarded to be safe.

During the course of these research work at the site of the study area, three important activities was observed to have taken place, these activities are soil erosion, degradation and deforestation.

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