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PHYSICO-CHEMICAL ASSESSMENT AND BACTERIOLOGICAL ASSAY OF SUB-SURFACE WATER IN EDE-ADEJO, IDAH LOCAL GOVERNMENT AREA OF KOGI STATE, NIGERIA

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Abstract: Physico-chemical studies and bacteriological assay of sub-surface water in Idah Local Government Area of Kogi State, North Central, Nigeria, were carried out to evaluate the probability and quality of the rural water supplies and to provide baseline data for future pollution studies using flame photometer, Atomic Absorption spectrophotometer, gravimetric method and pH meters. Water samples were collected at five different times from each of five boreholes located in different areas in Ede-Adejoh in the Local Government Area for analysis, using various standard methods. The annual mean values of chemical parameters in triplicate analysis of the various water samples showed the following results: pH 6 ± 0.6, COD 10.5m1/L ± 3.8, chloride ion (Cl^-) concentration of 53mg/L ± 0.5, sulphate ion ($S0_4^{2-}$) 4.10mg/L ± 0.04, sodium ion (Na^+) 0.54mg/L ± 0.1, potassium ion (K^+) 0.55mg/L ± 0.3 and calcium ion (Ca^{2+}) 0.04mg/L ± 0.6. The concentration of heavy metals included: Zn^{2+} 2.38mg/L ± 0.06, Pb^+ 0.08mg/L ± 0.04, Cd^{2+} 0.04mg/L ± 0.05 acid Hg^+ 0.004mg/L ± 0.005. The result also showed that the sub-surface water in Idah was free from coliform bacteria *(E. coli)* indicating the absence of faecal pollution. Compared with WHO standard for drinking water, pH was low, and within the acceptable limit by the WHO standard drinking water. Similarly, the concentration of total solids in water was also low compared with the standard. Low pH (in all the boreholes), high level of heavy metals lead, calcium, zinc, iron) seriously impair the quality of ground water in the area. However, treatment by boiling, addition of lime, sedimentation and filtration using appropriate medium could adequately improve the water quality and make it safe for drinking and other uses.

Keywords: Borehole Water, Low pH, heavy Metals Bacteria, Pollution, WHO Standards.

INTRODUCTION

Idah Local Government Area (LGA) is one of the administrative units in Kogi State, in North Central of Nigeria. It is a rural area with various development projects and growing population of 113,785 (1, 2) and land mass of approximately 315.34Sq km. The economy is largely agrarian. The various communities that make-up the Local Government Area live in small villages, which still have considerable natural surroundings. Agricultural wastes are traditionally discharged in gardens and orchards to serve as manure, while household wastes depending on the nature, are either buried or also used as manure. With modernity, management of human wastes has changed. Most people now use pit toilets, and few use water closet toilets instead of the traditional use of surrounding bushes.

There is no industry of note, only artesian works and low level commerce, consisting mainly of vehicular transportation. Nevertheless, the use of chemical fertilizers and pesticides in agriculture is becoming increasingly important in the area. There is no pipe born water supply, and although there are springs and streams, most of the communities rely on boreholes and hand dug wells for their water supply due to proximity and modernity. These boreholes and wells, which ranges in depth from 50 to 200 meters, from part of the state Government's

Primary Health and Community Development Programme [3] . The villages collect water from these boreholes and well and consume without any treatment.

Although boreholes and hand dug wells can provide good water, most of them are duged at sites with poor sanitation such as sewage discharge areas, suck-way pipe line leakages, agricultural fertilizers and pesticides invested areas, thereby quality limitations can occur as a result of inherent chemical constituents of permeable rocks through which water flows. [4, 5, 6].

Okoye and Adeleke [5] reported the occurrence of high nicked levels in shallow well waters in Akure mainly due to the geochemistry of the area. Also Umo and Okoye [6] reported that ground water in Nsukka area is naturally rich in iron. Generally, moderately low pH have characterized most of the ground water resources studied in Nigeria [5,6,7,8,9,10] with reported values ranging from 4.3 to 7.8. It is worth of note that the seepage of wastes busied in the shallow sub-surface (such as pit toilet, septic systems and social waste pit) can produce deleterious effects on ground water quality [5, 7, 8].

These have generated a lot of interest to ascertain and assess the quality of the water in such environment through the assessment of the levels of some parameters which serve as indices of water pollution [11]. Monitoring of water quality is of immense importance. Any pollution of water affects not only its quality but the health of the consumer community. There is yet no reported physico-chemical or bacteriological studies of ground water resources in Ede-Adejo of Idah Local Government Area. Therefore, this study is to assess the borehole and hand dug well water samples from this area in order to ascertain the portability and safety of water and procure the present quality status as baseline data for future periodic monitoring of the sub-surface water quality in this area.

Sampling

Water samples were collected at five different locations of boreholes and wells with rubber containers. The samples were clearly labeled for easy identification. The water samples were collected after adequately flushing the serve line (tap) and allowing the water to reach the ambient temperature. The samples were taken in new 2 – litre polyethylene cans which were first raised with AnalaR grade 1:1 HCl (BDH Ltd, poole, England), then copiously raised with de-ionised distilled water, finally with a borehole water. The labeled cans were corked immediately and put into ice before taken to the laboratory.

Chemical Analysis

pH was determined using a fisher brand Hydras 300pH meter. (Thermo orion, USA) while the conductivity was determined with a conductivity meter (Siemens Ms/cm). The remaining samples were preserved by refrigeration [13, 14].

Various standard methods [13, 14] were used to determine the total solids (TS), total hardness (TH), suspended solids (SS), dissolved carbon oxide (CO), chemical oxygen demand (COD), chloride (Cl^-), sulphate (SO_4^{2-}) were determined by EDTA titrations, chloride was by Mohr Argentometric titration, sulphate by turbidimetric method, sodium, calcium, potassium and magnesium were measured using a Gallen Kamp model 3y flame analyzer (Gallen Kamp, England). Samples for trace metal, analyses were concentrated by evaporating 500ML acidified with 2mL AnalaR grade conc. HNO_3 (BDH Ltd Poole England) to 50mL. The trace metals:

zinc, Lead, Iron, Copper, Cadmium and mercury were determined using an atomic absorption spectrophotometer equipped with air-acetylene flame. Sample blanks were run in all determinations to ensure accuracy and reagent purity.

Total bacteria viable count and coliform tests were carried out at the microbiology department, Kogi State University, Anyigba, using nutrient agar and Mac-Conkey agar respectively.

RESULT

The levels of some physico-chemical parameters are presented in table 1 in triplicate values, while mean values of triplicate analysis of the concentrations of metals are presented in table 2. Table 3 presents the results of the bacteriological analysis of Ede-Adejoh borehole and hand duged well water.

Table 1: Levels of Some Physico-Chemical Parameters of Borehole and Well Waters in Idah Local Government Area, Kogi State.

	Sample Points (Boreholes and Well)						
Parameters	Area 1	Area 2	Area 3	Area 4	Area 5	Mean -	SD -
pH (mg/L)	6.8	6.9	6.0	6.5	6.6	6.8	0.46
Total solids (mg/L)	42.3	42.10	41.2	42.60	41.60	42.0	4.2
Suspended particles	35.2	36.5	35.8	36.3	36.3	36.5	3.40
Temperature (^0C)	20	28.1	28	28	28	28	0.01
COD	9.84	10.54	11.0	10.5	10.2	10.5	1.24
Total Hardness (TH)	140	150	148	150	150	150	10.2
(Mg/L. $CaCo_3$) Dissolved CO_2	10.2	11.0	10.5	10.4	10.4	10.4	1.6
Cl^-(Mg/L.)	52	53	53	53	53	53	0.25
SO_4^{2-}(Mg/L)	4.04	4.10	4.0	4.0	4.0	4.1	0.32
Conductivity ($X10^2$)(us/cm).	1.08	1.9	1.7	1.6	1.7	1.8	0.60

Table 2: Metal Concentration (Mg/L) in Ede-Adejoh Borehole/Well Waters

(Samples) Borehole / Well Location	Na	K	Ca	Mg	Zn	Pb	Fe	Cu	Cd	Hg
Sample 1	0.6	0.5	0.04	1.60	2.50	0.09	0.18	0.01	0.04	0.005
Sample 2	0.70	0.50	0.50	1.61	2.30	0.08	0.17	0.01	0.04	0.005
Sample 3	0.51	0.50	0.05	1.60	2.40	0.09	0.18	0.02	0.05	0.005
Sample 4	0.55	0.80	0.04	1.58	2.40	0.09	0.18	0.02	0.05	0.005
Sample 5	0.52	0.90	0.04	1.57	2.35	0.09	0.18	0.02	0.04	0.004
Mean	0.54	0.55	0.04	1.59	2.383	0.088	0.018	0.017	0.043	0.0047
±	±	±	±	±	±	±	±	±	±	±
SD	0.04	0.30	0.06	0.05	0.06	0.04	0.004	0.005	0.005	

Table 3: Test for Coliform Bacteria *(E. coli)* in Borehole and Well Waters

Test	Observation	Inference
1. Sample 1 in test tube after 48hrs incubation	No gas bubbles, solution remained purple	*E. coli* absent
2. Sample 2 in test tube after 48hrs incubation	No gas bubbles, solution remained purple	*E. coli* absent
3. Sample 3 in test tube after 48hrs incubation	No gas bubbles, solution remained purple	*E. coli* absent
4. Sample 2 in test tube after 48hrs incubation	No gas bubbles, solution remained purple	*E. coli* absent
5. Sample 2 in test tube after 48hrs incubation	No gas bubbles, solution remained purple	*E. coli* absent

Table 4: Results of Bacteriological Analysis of Ede-Adejoh Borehole and Well Waters

Samples Point	Total Viable Count (Cfu/100ml)	Coliform (Cfu/100ml)
EU Std.	0	0
Sample 1	1.3×10^2	0
Sample 2	0.2×10^2	0
Sample 3	0	0
Sample 4	0	0
Sample 5	0.8×10^2	0

The lowest pH 6.0 was measured within the acceptable limit of the World Health Organization (WHO) standard for drinking water [17]. The pH value of the various water samples did not show significant differences (p>0.05). The range of mean values – 6.0 to 6.8 falls within the WHO standard range of 6.5 to 8.5. Standard pH has characterized most studied ground water in the area.

Mean conductivity values range from 1.08×10^2 to 1.8×10^2 MS/cm with the lowest determined value in the borehole located in sample 1. The highest conductivity was measure from sample 2 and has the highest concentration of sodium (Table 2). The value of chloride ion (Cl^-) was 53mg/L and this was good and meets the WHO standard. There was no significant differences (p > 0.05) in chloride values between the boreholes.

The values for total hardness, ranging from 140 to 150mg/L, show that the ground water in Ede-Adejoh area is plain soft. WHO standard is 150 – 500mg/L $CaCO_3$[12]. Soft water has been associated with rickets in children [15] and cardiovascular diseases. On the other hand, hard water is associated with rheumatic pains and goiter [16].

The concentration of sulphate was very high. The implication of the high concentration of sulphate ion (SO_4^{2-}) is that it could lead to the increase in the total hardness of the water as the sulphate ion (SO_4^{2-}) may react with the calcium (Ca^{2+}) and magnesium (mg^{2+}) ions to form calcium and magnesium sulphate salts responsible for the hardness.

$$Ca^2 + {SO_4}^{2+} \rightarrow CaSO_4$$

$$Mg^{2+} + {SO_4}^{2+} \rightarrow MgSO_4$$

The data on metals presented in table 2 shows that the concentration of Na, K, Ca, and Mg were within WHO standard for drinking water. However, these metals were in significantly higher concentrations (P < 0.05) in some of the samples from the boreholes and wells.

Copper had values ranging from 0.01 to 0.02 mg/L while WHO standard is 2mg/L. Lead was detected in all the boreholes (0.08 – 0.09). The WHO standard for lead in drinking water is 0.01mg/L. These are isolated cases of lead contamination, and a probable reason for high concentration may be the use pipes or corrosion of lead soldered pipe joints in the acidic water. Cadmium was found in all samples from the boreholes ranging from 0.04 to 0.05, all exceeding the WHO maximum of 0.03mg/L. Calcium is naturally found in very low concentration in rocks, coal and petroleum and could enter ground and surface waters due to dissolution by acidic waters, and so become wide spread. Iron range from 0.17 to 0.18mg/L in all samples. The WHO standard for 0.3mg/L is exceeded in all samples analyzed. Apart fro minerals, another source of iron could be corrosion of the machinery and pipelines. The concentration of mercury of 0.05mg/L was high compared to 0.02mg/L recommended by WHO. The concentration of lead and mercury (Hg) suggest which has appreciable level of pollution of some health implications such as kidney damage in adults, gastro-intestinal problem and delay in physical and mental development in children [18].

Table 3 and 4 shows that all the boreholes and well are free from faecal contamination since no growth of coliform bacteria well observed. This suggests that the sub-surface water was free from both human and animal faecal wastes.

CONCLUSION

The results of this study have shown that most boreholes and wells in Idah Local Government Area are free from coliform bacteria *(E. coli)*. Though most of the areas have suffered one or more types of significant contamination from localized influences which are mostly geochemical origin; the contamination of lead, mercury at the elevated concentrations in all samples could be due to corrosion of pipes and its joints by acidic rain water.

The surface water was unfit as a source of potable water for dwellers due to the high concentration of some heavy metals such Lead (Pb), Cadmium (Cd) and Mercury (Hg).

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