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Physicochemical status of water samples from hand-dug wells in Ajebamidele area of Ado-Ekiti, Southwest, Nigeria

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ABSTRACT

Physicochemical analysis of water samples from hand-dug wells in Ajebamidele area of Ado-Ekiti, Southwest, Nigeria were carried out in order to assess the quality of water from these sources. Samples were taken from 24 evenly distributed wells and 20 parameters were determined. The results showed variations in physicochemical quality of water from the hand-dug wells. A synthesis of the data indicates that most of the well waters are potable since the concentrations of ions in majority of the samples are below the maximum permissible level indicated in the World Health Organization (WHO) standards. Complimentary pre-use treatments would enhance the quality status of the well water as desirable.
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Keywords: Regolith, pollution, potability, wells, parameters.

INTRODUCTION

The water distribution system in Ado – Ekiti, Southwest, Nigeria is grossly inadequate for consumers due to astronomical increase in human population, logistics and leakage. This inevitably undermines the confidence of consumers, resulting to complaints and possibly the use of water from unhygienic sources. Most homes now depend on water from hand – dug wells.

Ajebamidele is a fast growing community in the outskirts of Ado-Ekiti metropolis. It depends on rain water, surface water and groundwater for its water supplies. It is underlain by crystalline rocks of the Basement complex, which is highly weathered, fractured, jointed and faulted. The thickness of the regolith varies greatly. On this, hand-dug wells and boreholes are sunk (Olorunfemi et al., 1999; Rahaman, 1988). Consequently, the groundwater quality status of the area must be ascertained and its contamination made prohibitive.

The threat to the safety and quality of water resources originated from water itself in the form of wastewater. Almost all water used by man turns into wastewater, which requires proper disposal to prevent it from polluting water sources such as rivers, Lakes and groundwater/wells. Pollution of groundwater may also occur due to the contamination potential of leachate from open dumps and sanitary landfills (Badmus et al., 2001). Safe water supply and proper wastewater disposal is one of the preventive measures in controlling groundwater pollution. Water and wastewater are interrelated environmental components that mutually complement each other. Due to this complimentary relationship, water and waste projects must be designed, constructed and maintained simultaneously (Adelusi et al., 2004).

In general, it is cheaper to protect good quality groundwater supplies from contamination than to apply extensive treatment to sources that are already contaminated. Groundwater sources are often of good quality and may only require protection and disinfection in order to provide good quality sources of water for drinking

(Caincross and Feachem, 1983; Makeig, 1982). Groundwater is significantly protected from surface pollutants as the earth media (composed of different subsurface layers) act as natural filter to infiltrated water. It very rarely needs to be treated before consumption hence cheap to develop (Olorunfemi et al., 1999).

The quantity and quality of water consumption is directly linked to health. Outbreaks of water - transmitted diseases have a major impact on human health. The quality of water is thus, of vital concern for mankind since it is directly linked with human welfare (Adefemi et al., 2007). Pollution of groundwater is indicated by the presence of toxic materials or unwanted materials that may arise from human activities or natural sources (Okoli et al., 2005; Badmus et al., 2001). The central objective of this work is to determine the physico-chemical quality of water from hand-dug wells in the study area. The community is heavily dependent on such wells for various activities. The result of this study would offer a guide on the quality status of the hand-dug wells in the community and create general environmental awareness.

MATERIALS AND METHODS

Water samples were taken from 24 hand-dug wells with an even spread within the study area using the Grab water sampling technique (Okoli et al., 2005; Badmus et al., 2001). The samples were collected early in the morning between the hours of 6:00 a.m. and 9:00 a.m. into clean and sterilized bottles with stoppers firmly in place. The temperature of each sample and a couple of other parameters were determined immediately at the point of collection. Various standard methods were used for the determination of other parameters in the laboratory (Adefemi et al., 2007).

A total of twenty (20) parameters were determined including colour, odour, temperature, taste, turbidity, conductivity, pH, hardness, total dissolved solids, total suspended solids, chlorides, nitrates, dissolved oxygen, ammonia, magnesium, calcium, Carbonate and Bi-carbonate Alkalinity.
All the data generated were subjected to simple descriptive statistics such as averages, percentages, standard deviations and charts (Karunakaran et al., 2009; Jafari et al., 2008).

The parameters identified were measured against the provisions of the World Health Organization (WHO) standards for potable water.

Any water supply must be judged on its properties as a whole. The acceptability of water is evaluated in terms of the quality requirements for a specific beneficial use (Okoli et al., 2005). In the case of drinking water, temperature and taste are among the important criteria. Factors such as saturation values of solids and gases dissolved in water, Bio-chemical oxygen demand, B.O.D values and the Biological activities are dependent on temperature of water. The suspended solid content, which is judged only partly from the standpoint of turbidity, is also one of the essential properties. Turbidity, a common water quality indicator can influence taste and colour of drinking water. Turbidity is imparted by the colloidal matter present in water which may be clay and loam or microscopic organisms. Good drinking water must not have colour, odour or taste. It must be void of chemical impurities (Adeyeye and Abulude, 2004; Oteze, 1990; Dezuane, 1979)

RESULTS

The results obtained are displayed in Tables 1-3. Charts of comparative forms of interrelated parameters are also presented in Figures 1 - 6.

The colour rating of the water samples ranged between 5 and 60 (an average of 15.21 ± 13.79 HU) with average values of 80.95 ± 108.29 mg/l for Total solids and 28.91 ± 55.99 mg/l for suspended solids respectively.

The mean value of Temperature of the samples was 27.65 ± 0.60 ^{o}C with the pH values averaging 6.51 ± 1.22 for the area. The concentrations of Calcium in the wells ranged between 4 and 346 mg/l with mean value of 63.93 ± 67.97 mg/l while values obtained for Magnesium ranged between 9.5 and 140 mg/l with an average of 58.40 ± 29.98 mg/l. Total Hardness in the samples varied from 20 – 420 mg/l with a mean value of 124.58 ± 85.77 mg/l.

Chlorides concentrations in the wells ranged between 4.5 and 480 mg/l with mean value of 92.35 ± 104.81 mg/l while the

Table 1: Physicochemical analysis of Ajebamidele hand - dug wells.

Well No.	Appearance	Odour	Taste	Colour (HU)	Turbidity (NTU)	Total Solid(mg/l)	Uspended Solid (mg/l)
1	Not clear	Odourless	Tasteless	5	1.02	3.5	0
2	Not clean	Objectionable	Bitter	10	8.5	12	6
3	Clean, clear	Odourless	Tasteless	20	5.58	25	0.75
4	Sparkling	Odourless	Tasteless	5	18.55	90	4.9
5	Not clear	Objectionable	Muddy	60	105.5	420	160
6	Clean	Odourless	Tasteless	5	5.7	5.5	2.5
7	Clean	Odourless	Tasteless	5	1.05	4.7	0
8	Clear	Objectionable	Bitter	5	12.05	4.9	2
9	Clean, clear	Odourless	Tasteless	5	1	2.7	0
10	Dark	Odourless	Very hard	15	35.7	25	9
11	Brownish	Objectionable	Decay	10	55	32	200
12	Dark	Objectionable	Sewage	40	30.7	185	90
13	Sparkling	Odourless	Tasteless	40	24.75	14.8	5
14	Clear	Odourless	Tasteless	5	25.5	9	1.5
15	Clear	Odourless	Hard	10	21.7	41	12
16	Dark	Objectionable	Very hard	15	35.7	25	9
17	Not clear	Objectionable	Rotten	5	29.1	100	2
18	Brownish	Odourless	Tasteless	5	25.5	145	8.8
19	Sparkling	Odourless	Tastless	20	18.55	90	4.9
20	Clean, clear	Odourless	Tasteless	15	5.58	25	0.75
21	Clean, clear	Odourless	Chlorious	15	4	55	0.25
22	Not clear	Odourless	Tasteless	20	5.5	61.7	27.5
23	Not clean	Objectionable	Very hard	10	30	230	130
24	Not clear	Odourless	Slightly hard	20	12.05	48	17
Max				60	105.5	420	200
Min				5	1	2.7	0
Mean				15.21	21.60	80.95	28.91
SD				13.79	22.63	108.29	55.99

Table 2: Physicochemical analysis of Ajebamidele hand - dug wells.

Well No.	pH	Temperature (°C)	Electrical Coductivity	Calcium (mg/l)	Magnasium (mg/l)	Total Hardness (mg/l)
1	6.8	27.1	18.6	40	135	100
2	3.5	28	7.91	346	56	420
3	7.8	29	5.02	45	61.5	100
4	6.5	27.5	15.5	92	40	20
5	5.8	27.2	33.05	14.14	9.5	140
6	7.2	29	4.5	10	21	80
7	6	27.6	7.75	4	76.3	70
8	7.5	27.6	7.85	45	40	140
9	7.8	28	8.5	5.6	43.5	180
10	5.8	27	5.75	42	70	40
11	7.5	27.4	25.75	146	88	100
12	8.2	27.6	15.5	98.5	140	200
13	6.5	27.8	20.4	56	27	160
14	7.5	27	18.2	42	40.5	100
15	6.2	27.8	11.5	70	55	80
16	5.8	27.4	5.75	42	70	7
17	7	27.6	16.5	60	45	200
18	5.5	27.8	20.55	40	60	180
19	6.5	27.5	15.5	92	40	20
20	7.8	29	5.02	45	61.5	100
21	7.2	27.3	5	40	50	80
22	5.5	27	4.9	55	60	100
23	6.8	27.5	7.55	59	60.5	100
24	6.8	27.5	7.55	59	60.5	100
Max	8.2	29	33.05	346	140	420
Min	3.5	27	4.5	4	9.5	20
Mean	6.51	27.65	12.98	63.93	58.40	124.58
SD	1.22	0.60	8.01	67.97	29.98	85.77

concentrations of nitrates were quite minimal; the mean value being 2.46 ± 8.12. The Ammonia values of the well samples are generally low (0.01 – 2.00) with an average of 0.63 ± 0.53. Carbonate and Bi-carbonate Alkalinity values in almost all the well samples were low with 7.60 ± 12.37 and 98.22 ± 74.21 as the mean values respectively.

DISCUSSION

High values of colour rating recorded in wells 5, 11 and 23 were in consonance with the high values of turbidity exhibited by these samples (Figure 1). The very high value of turbidity in well sample 5 might be due to high sediment discharge from run - off. All the sampled wells have their values for colour lying within the WHO recommended belt except for well sample 5 with the value of 60. Colour in water is attributable to materials in solution (Karunakaran et al., 2009; Adeyeye and Abulude, 2004; Ojelabi, 2001). Affected wells can be treated by Coagulation, Activated carbon and Chlorination. 67% of the samples are odourless with similar patterns displayed in taste and appearance. Taste and odour are of prime importance in assessing the palatability of water (Dezuane, 1979).

Figure 2 shows that most of the sampled wells are within the WHO limit for pH values except wells 2, 18, 22 and 23

Table 3: Physicochemical analysis of Ajebamidele hand - dug wells.

| Well No.	Ammonia	Nitrate (mg/l)	Chloride (mg/l)	Dissolved Oxygen(ppm)	Acidity (mg/l)	Carbonate Alkalinity	Bi-Carbonate Alkalinity
1	1	0	80	5	1.5	0	97.6
2	1.5	0.5	480	4.05	2.5	0	245
3	0.1	0.15	12	6.75	0.2	0	45
4	0.75	1	100	4.93	1.5	1.2	60
5	0.6	0.15	132	4.87	2	15	160
6	0.1	0.15	4.5	8	1	0	30
7	0.1	1	75	4.5	0.3	0	35
8	0.01	1	24	11.76	0.2	40	60
9	0.1	1	85	60	0.3	0	122
10	1	1.5	32	4.84	0.1	10	69
11	2	40.5	75.9	4.96	0.5	0	70.15
12	1	0.3	142	4.58	1.5	0	75
13	1	0.3	142	4.58	1.5	0	75
14	0.75	0.3	10.9	4.84	0.5	0	45
15	1	1	100	4.65	0.2	25	75
16	1	1.5	32	4.84	0.1	10	69
17	1	1	175	4.78	2	25	150
18	0.75	1.5	190	11.65	1.5	35	255
19	0.75	1	100	4.93	1.5	1.2	60
20	0.1	0.15	12	6.75	0.2	0	45
21	0	1	60	4.6	0.2	0	35
22	0.3	1.6	25	4.89	0.5	0	40
23	0.15	0.3	15	4.35	1	0	266
24	1	1.5	9.15	5	0.4	20.1	48.5
Max	2	40.5	480	60	2.5	20.1	266
Min	0.01	0	4.5	4.35	0.2	0	30
Mean	0.64	2.46	92.35	7.93	0.90	7.60	98.22
SD	0.53	8.12	104.81	11.28	0.76	12.37	74.21
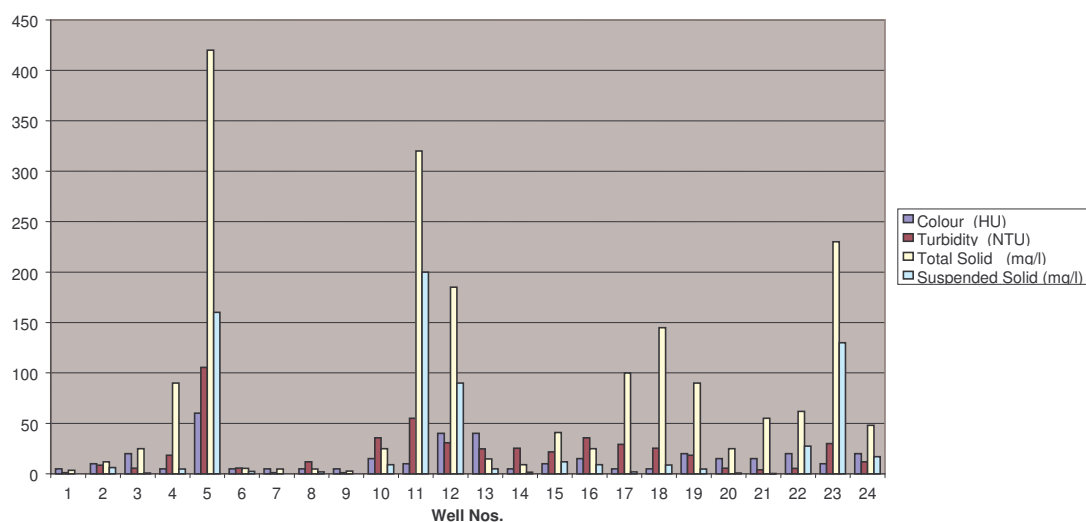
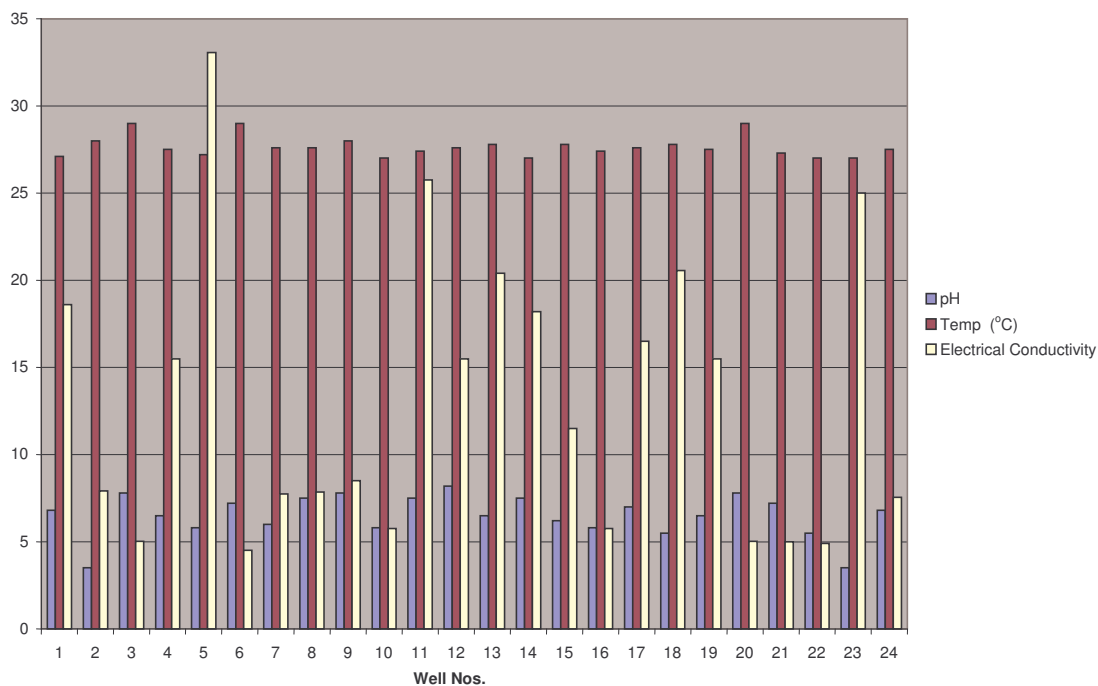**Figure 1:** Physicochemical analysis of Ajebamidele hand-dug wells.

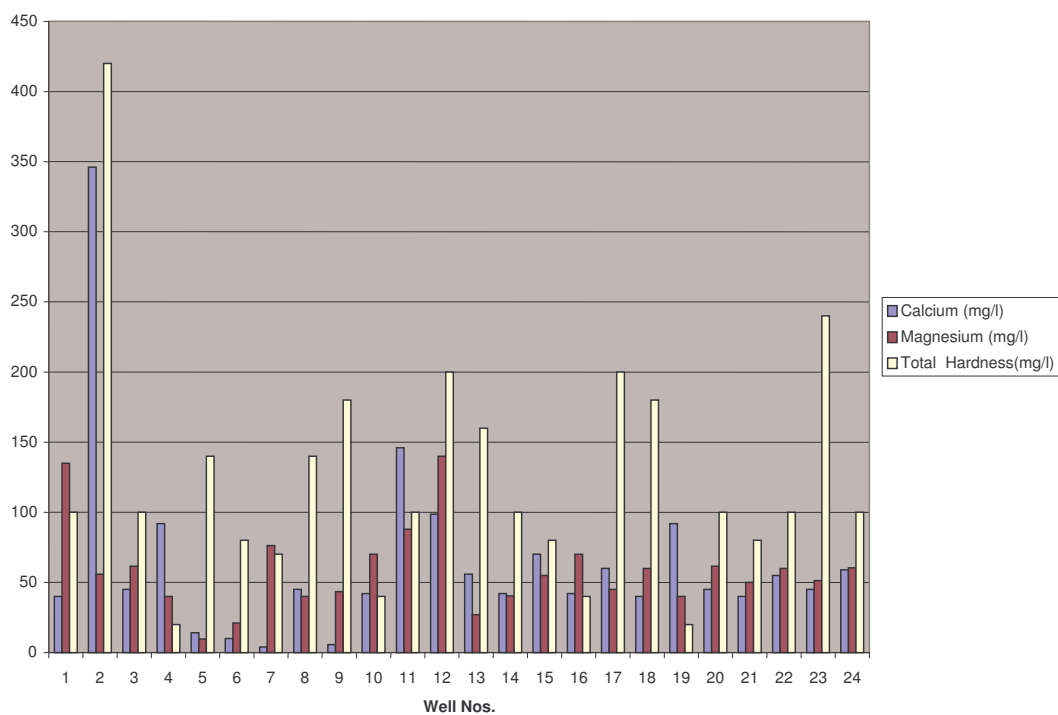**Figure 2:** Physicochemical analysis of Ajebamidele hand-dug wells.

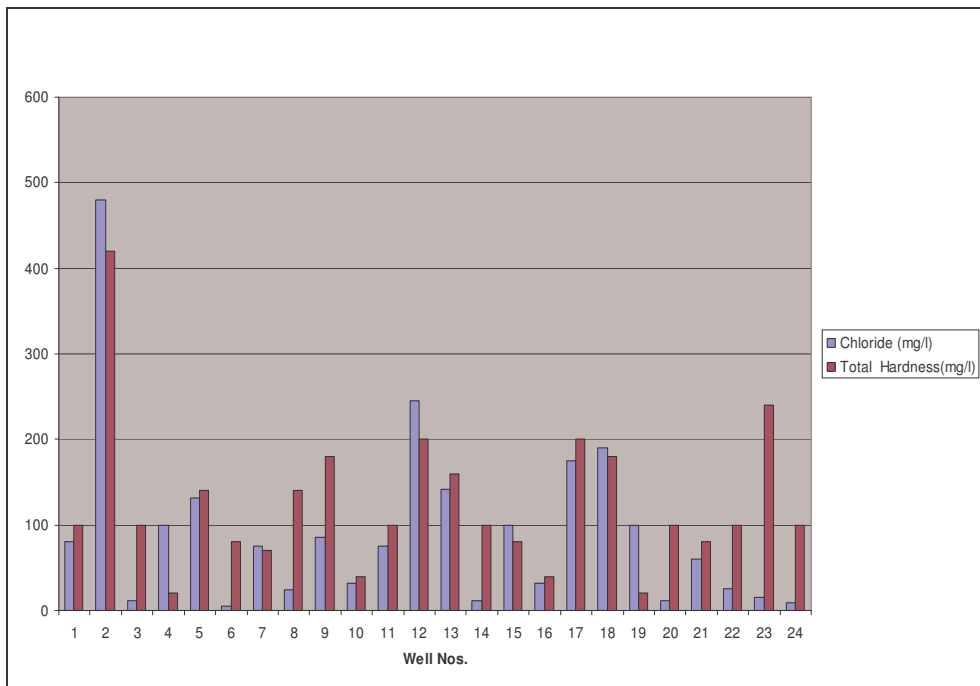**Figure 3:** Physicochemical analysis of Ajebamidele hand-dug wells.

Figure 4: Physicochemical analysis of Ajebamidele hand-dug wells.
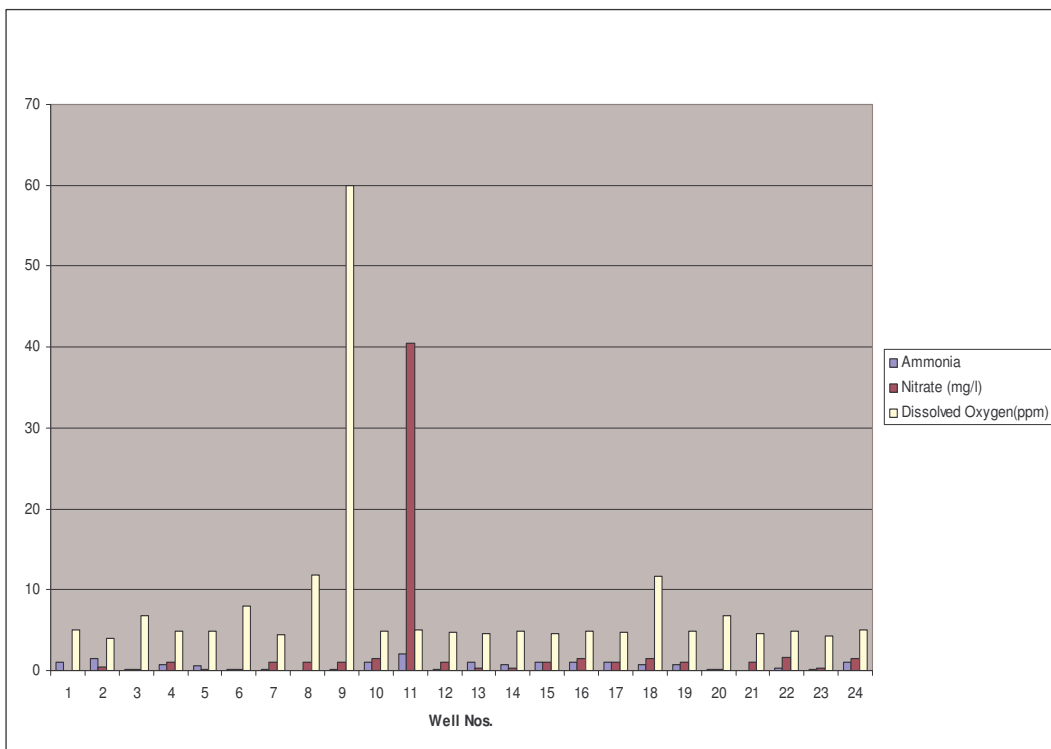

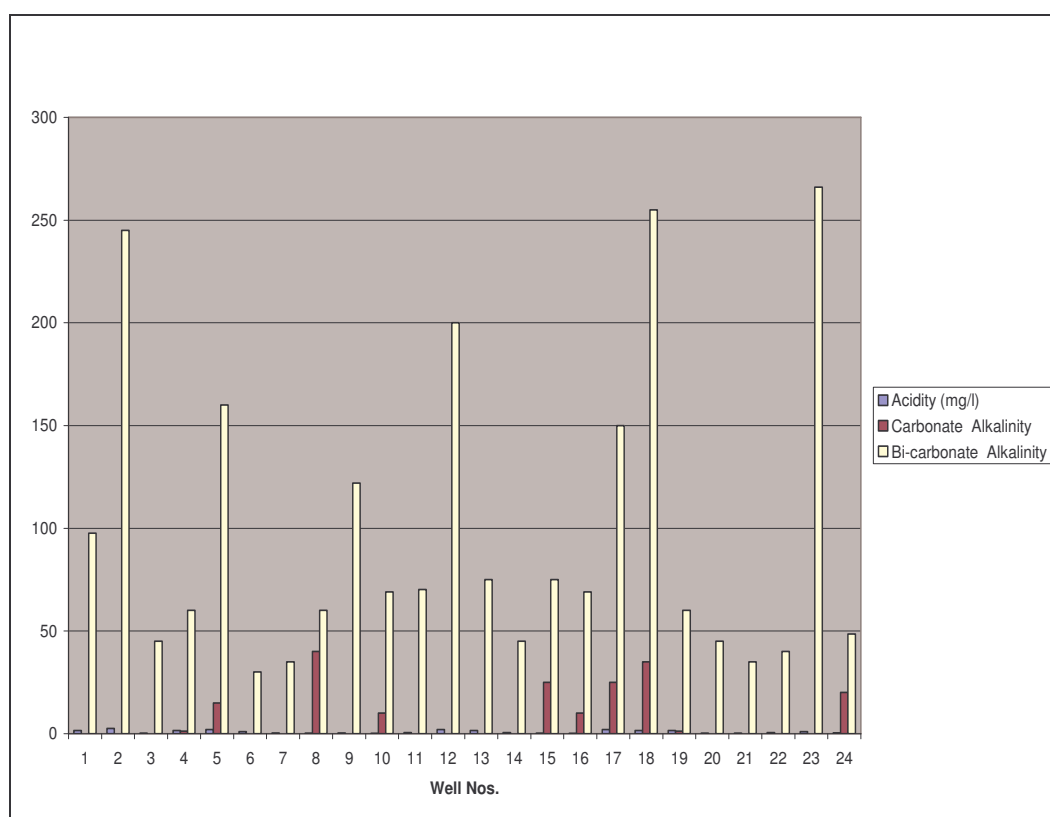**Figure 5:** Physicochemical analysis of Ajebamidele hand-dug wells.

Figure 6 : Physicochemical analysis of Ajebamidele hand-dug wells.

which are slightly acidic. Similar values, a range of 5.90 to 7.60, were obtained by (Adeyeye and Abulude, 2004) in the analytical assessment of some surface and groundwater resources in Ile-Ife, Nigeria. Pre-use treatment by adding lime is required for affected wells.

Calcium and magnesium are the prime constituents concerned with hardness. Total hardness, made up of temporary hardness and permanent hardness, is due to the presence of certain dissolved salts, such as carbonates, bi-carbonates, chlorides and sulphates, of calcium and magnesium. Calcium and magnesium are the prime constituents concerned with hardness (Figures 3 and 4).While temporary hardness could be removed by boiling water and by adding lime to water, permanent hardness requires special methods of water softening. Excessive hardness is objectionable as a great deal of

soap is required for washing. Formation of scales in boilers/heating systems, corrosion and incrustation of pipelines and plumbing fissures are also promoted (Caincross and Feachem, 1983). Average Total Hardness of 124.58 ± 85.77 mg/l observed in the area is within the tolerable limit of the WHO standards except Well 02.

Natural nitrate levels in groundwater are generally very low (typically less than 10 mg/l NO_3), but nitrate concentrations grow due to human activities, such as agriculture, industry, domestic effluents and emissions from combustion engines (Ojelabi, 2001; Makeig, 1982). The ammonia values of the well samples are generally low. The bi-carbonate alkalinity values are however noticeably high in well samples 2, 18 and 23 (Figure 6).

The concentrations of ions in majority of the samples are below the maximum

permissible level indicated in the World Health Organization (WHO) standards. Simple treatment involving the addition of chlorine, alum and perhaps boiling and filtration should be encouraged among the residents as harmful bacterial could be removed by boiling and/or by adding water treating chemicals (Shitta and Oyedele, 2007). In locating a well in future, a geophysical survey should be carried out so as to decipher the subsurface overburden thickness, structural dispositions and the most probable aquiferous zone. This is necessary because the level of contamination of hand-dug wells might not only be related to the depth of the well but also the fracture intensity (Oyedele et al., 2005).

Water pollution control must be recognized as an integral part of water resources management and given due consideration along with irrigation, flood protection and water supply in national water planning as lack of concern for water pollution control may lead to adverse aesthetic and health consequences. There is an urgent need in most developing countries to manage water as a natural resource both in terms of quantity and quality for the benefit of society rather than the individual.

Conclusion

Most of the well waters are potable since the concentrations of ions in majority of the samples are below the maximum permissible level indicated in the World Health Organization (WHO) standards. Indiscriminate siting of refuse dumps and other waste disposal facilities should be discouraged in the area to avoid the unpleasant consequences of polluting the near surface/shallow hand–dug wells.

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