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Quality Assessment of Water from some Hand Dug, Ringed and Covered Water Wells from some Private Households in Falegan Area of Ado Ekiti (Ekiti State, Nigeria) Metropolis

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Abstract

Water is one of the indispensable resources for the continued existence of all living organisms. The provision of an adequate supply of safe drinking water is a global priority. This study investigated some physicochemical, elemental and microbial properties of water from some hand dug, ringed and covered water wells in 10 (Ten) different private households at Falegan area of Ado Ekiti, Ekiti State, Nigeria. The water samples were analysed for pH, temperature, hardness, total solids, ammonia nitrogen, dissolved oxygen, some minerals elements, total plate count and coliform count.

pH of the well water samples ranged from 6.8-7.2 while the temperature was 25-27^{0}C. The samples odour and taste were unobjectionable while the colour was 5.0 NTU. Dissolved oxygen was 129-143 mg/l, total solids 146-216 mg/l. Total alkalinity was 07-21 mg/l and chloride content was 54– 98 mg/l. Ammoniacal nitrogen was not detected in the water samples and total acidity was 12-21 mg/l.

Results of microbial analysis indicated that there was no gas producing organism in any of the water samples, coliform bacteria was not detected, while total plate count ranged between 2-4 cfu/ml.

Elemental analysis showed that lead, chromium, cadmium, mercury, nickel, arsenic and copper were not detected in any the water samples. Zinc ranged from 0.1-1.2 ppm, calcium ranged between 68-86 ppm while magnesium was between 34- 68 ppm.

These results imply that these water samples were within WHO minimum standards for potable water, hence, they can be used for domestic or other applications.

Keywords: Supply, pollution, disease, health.

Introduction

Water is a chemical substance composed of hydrogen and oxygen and exists in gaseous, liquid and solid states. It is very essential to all known forms of biological life. Water is a clear colourless, odourless, tasteless liquid that freezes into ice below 0^0C, and boils above 100 ^{0}C. The chemical formula of water is H_20 and has the important attribute and ability to dissolve many other substances (Alexander 2008; Kaonga *et al*., 2013). Indeed the versatility of water as a universal solvent is essential to living organism. Life is believed to have originated from aqueous forms from the world's ocean, and living organism depends solely on aqueous solution as blood and digestive juice, for biological process. Although the molecules of water (H_20) may look quite simple, however, the physical and chemical properties of the compound are extraordinarily complicated, and they are not typical of most substance found on earth (Osei yaw 1985; Olukanmi *et al*., 2014).

Water can be naturally derived from three main sources; rain water, ground water and surface water. Rain water is naturally the purest source of water but as it gets down it absorbs compounds from the atmosphere. Its main components are chlorides, nitrates, sulphates, sodium, potassium and ammonia. The concentration varies. Rain water can be collected from roofs and prepared water sheds which could assist in polluting and making it one of the most unfit sources of water for drinking (Olukanmi *et al*., 2014; Oluwasola *et al*., 2017; Okunade *et al*., 2018). Ground water are said to have emanated from the melting of meteoric water (rain, snow, and hailstone), into the ground, they have served as source of domestic water supply. The oceans hold about 97% of earth's water. More than 2% is locked up in ice in the polar caps, and over 75% of the fresh water of the world is ice of the 1% of the liquid fresh water. Surface water includes streams, ponds and lakes, its main ionic compounds include chlorides, nitrates, sulphates, magnesium and calcium. The concentration of components here are more than those in rain water and ground water. Sea water could be considered as surface water. The salt content in it is so much that it cannot be used as drinking water (Kaonga *et al*., 2013; Frederick 2010).

Ground water represents an important source of drinking water and constitutes the largest source of hand dug well water. Water from these shallow and deep wells is often of better quality than surface open water source, if the soil is fine grained and its bedrock do not have cracks, bedding plant, which permits the free passage of polluted water. The availability and purity of groundwater are affected by location, construction and operation of the well. It is often assumed that natural, uncontaminated water from deep wells is clean and healthy, this is actually true with regards to bacteriological composition. However, this might not be a general rule, since some water wells may sometimes be situated near heavy contamination sources like waste dumps, sewage and septic tanks (Oparaocha 2008; Leticia *et al*., 2009; Adesina & Okunade, 2012).

From the foregoing, water quality poses a challenge worth investigating. It is on this premise that the present study set for itself the task of assessing the quality of well water from some households in Falegan area of Ado Ekiti metropolis. This is with a view to ascertaining its suitability for consumption, domestic or other applications.

Materials and methods

Materials and sample collection

2L glass sampling bottles were obtained from BISO Lab in Ado-Ekiti. Plastic bucket fetcher and thin trawling rope were procured from the public market in Ado Ekiti. The rope was attached to the bucket fetcher. The sampling bottles were coded, wrapped with aluminum foil with the lidsand sterilized in an autoclave at 121^0C for 15 minutes. The plastic fetcher and rope was heated for 15 minutes at 100^0C in an oven, the nallowed to cool.

All the samples from the previously identified households were collected in triplicates early in the morning within 2 hours, using the same bucket fetcher. The plastic bucket fetcher alongside the attached ropes was rinsed thoroughly with de-ionised water after each sample collection.

All the water wells in the identified households were ringed and covered, and had not been chemically treated within the last three months pre sampling. The well water samples were collected in the month of January, well before the start of the raining season in Nigeria.

Table 1.Sample coding

Sample Code	Household name
01	Baba OT House
02	Daddy P Place
03	Daddy Wande House
04	Daddy Olu Place
05	Daddy POS House
06	Twins Place
07	Favours Place
08	Lebannon Quarters
09	Virgas Island
010	Americana Place

Sample treatment

The water samples for elemental analyses were treated as described (Saxena1990; Adesina and Akinyele 2006; Adesina and Okunade2012). Samples were treated with 5mL concentrated nitric acid (Analar grade) per litre and 100mL aliquots of the samples were mixed with 15mL mixture of nitric and sulphuric acids (Analar grade). The mix was heated on an electric hot plate, allowed to cool and filtered using micro filters (0.45µm). The filterate was then made up to 100mL with deionised water. The digest was used for elemental analysis.

Sample analysis

Temperature and pH evaluation was done immediately on site after each sample collection. The temperature was evaluated using a field hand held thermometer while the pH was evaluated using Metroph pH meter (Model E520). Sample for microbial evaluation was evaluated within 3 hours post sample collection, while all physicochemical analysis was carried out within 5 days post well water sampling.

Colour, taste, turbidity and odour of the water samples were determined immediately on sample arrival in the laboratory using methods as described by Ademoroti (1996) and adapted by Adesina and Okunade (2012). Total and dissolved solids were done using gravimetric methods as described (Ademoroti, 1996; AOAC, 1990). The chloride content determination was evaluated using $AgN0_3$ as the precipitant. Total alkalinity, acidity and water hardness were done using titrimetric methods as described by Ademoroti (1996) and AOAC (1990). Ammonia nitrogen and dissolved oxygen content were evaluated as described by AOAC (1990). Sulphate content was determined using turbidimetry method while spectrophotometric method was used in nitrates determination (Ademoroti, 1996; AOAC, 1990; Adesina and Okunade, 2012).

Elemental analysis was done as described by Saxena (1990) using Perkin Elmer (Model 200) atomic absorption/emission spectrophotometer after digestion of the water samples.

Total viable count was determined as described by Pelczar *et al*., (1998) and Adegoke (2000) using total count agar, presumptive coliform test was done using macconkey broth agar while coliform count was carried out using eosin methylene blue agar (Adegoke, 2000).

Data analysis

All experimental analysis was done in triplicates. The average of the triplicate determination was taken as the representative results.

Results and discussion

Physicochemical properties of water from hand dug, ringed and covered wells in some private households in Falegan, Ado Ekiti, Nigeria

Table 2 presents the physicochemical properties of some well water in Falegan area of Ado Ekitimetropolis.

Table 2.Physico-chemical properties of well water from some private households in Falegan, Ado Ekiti, Ekiti State

Water Sample										
Parameter	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**010**
pH	6.9	7.0	7.3	7.0	7.2	7.0	7.1	7.0	7.2	6.9
Colour (NTU)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Turbidity (HU)	4.0	4.0	5.0	5.0	4.0	5.0	5.0	4.0	4.0	5.0
Odour	Uo	Uo	Uo	Uo	Uo	Uo	Uo	Uo	Uo	Uo
Taste	Uo	Uo	Uo	Uo	Uo	Uo	Uo	Uo	Uo	Uo
Temperature (^{0}C)	27	26	26	25	26	27	26	27	26	27
Acidity (mg/l)	18	26	24	22	25	19	21	24	29	28
Alkalinity (mg/l)	14	22	17	17	20	16	18	21	23	23
Total solids (mg/l)	186	232	228	246	228	186	238	240	220	236
T. Sus. solids (mg/l)	124	148	162	118	132	126	139	146	130	152
T. diss. solids (mg/l)	318	389	398	376	364	322	388	320	264	348
Amm. Nit (mg/l)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Dissolved 0_2 (mg/l)	143	134	129	130	190	188	180	168	146	158
Phosphates(mg/l)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Hardness (mg/l)	28	65	44	46	55	48	56	48	36	56
Chlorides (mg/l)	44	39	68	78	68	54	62	52	58	46
Nitrates (mg/l)	0.2	0.3	0.2	0.3	0.3	0.1	0.1	0.2	0.1	0.3
Sulphates(mg/l)	0.1	0.3	0.1	0.4	0.3	0.2	0.2	0.2	0.2	0.1
Res. Chl (mg/l)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

**** Uo: Unobjectionable

All the water samples had unobjectionable odour and taste. The colour of all the water samples was 5.0 NTU while turbidity was very low. Turbidity has been described as a measure of water cloudiness, and may be a medium for microbial growth which may encourage rapid water pollution (Adesina and Okunade 2012; Akoto and Adiyah 2007).pHof the water samples ranged from 6.9– 7.3 which is considered adequate for drinking water. The dissolution of acidic gasses from the atmosphere by rain, and the subsequent infiltration of this acidified water to ground water are believed to be largely responsible for influencing groundwater pH (London *et al*, 2005; Adekunle *et al*, 2007). The well water alkalinity ranges from 14 - 22 mg/l, alkalinity of water refers to its ability to neutralize acids. Dissolved oxygen was very high in all the samples (129—190 mg/l) indicating that the water samples are fresh and well aerated, and does not contain any oxygen depleting organisms (Agbaire *et al*., 2009; Adesina & Okunade 2012). Nitrates was low (0.1 -0.3 mg/l) while ammonia nitrogen was not detected in any of these water samples which is indicative of the absence of decaying materials. High nitrate content of domestic water is mostly attributed to the presence of decaying plant and animal materials and may also imply sewage contamination of water (Terbutt 2018; Leticcia *et al*., 2009), it can also be deduced that relatively high nitrate values of domestic water may be due to leaching from sewages, pit latrines and refuse dump located close to wells. Phosphate was not detected in any of the samples.

Water hardness ranged from 28-65 mg/l, hard water is known to cause formation of scale, which may cause problems in boilers. Residual chlorine was not detected in any of the samples, implying that all the wells had not been previously treated with chlorine, a common water disinfectant (Terbutt2018).

The results obtained for the physicochemical properties of these water samples were largely within the WHO standard for potable water. These results are similar to previous studies as reported byAdesina and Akinyele (2006), Okunade*et al* (2018) for water supplies in public restaurant and for some well water in Ado Ekiti, Ekiti State, Nigeria respectively.

Elemental composition of water from hand dug, ringed and covered wells in some private households in Falegan, Ado Ekiti, Nigeria

Table 3 depicts the mineral content of well water samples from some households in Falegan area of Ado Ekiti, Ekiti State. Lead, chromium, cadmium, mercury, nickel, arsenic and copper were not detected in all the water samples, which is desirable, toxicity from heavy metals has been linked to low level, long term exposure to pollutants in our environment, air, soil, water, food and other consumer or household products (Goyer 1991; 1988).Zinc content ranged from 0.2-0.8 ppm while magnesium ranges from 38-58 ppm. Zinc is known to have gastro-intestinal effects on human at a higher concentration and can cause liver damage (WHO, 2013; Goyer 1991; Saleh*et al*., 2001). Magnesium, an activator of many enzymes systems also assists in maintaining the electric potentials in nerves. Calcium ranges 62-96 ppm, below WHO limit of 200 ppm. Calcium in conjunction with other minerals (phosphorous, magnesium, manganese etc) and protein, are all involved in bone formation and is also important in blood clotting, muscle contraction and in certain enzymes metabolic processes (Alexander 2008; Frederick 2010). Iron ranges from 0.02 to 0.06 ppm which can be considered moderate. High iron content in water has been implicated in aiding the growth of micro-organisms, producing an off taste in the water, it also imparts colour and aids corrosion (Alexander 2008; Agbaire 2009). Sodium ranged from 36-64 ppm. Sodium is required to maintain the osmotic balance of the body fluids, pH of the body, regulate muscle and nerves irritability and control glucose absorption (ATSDR 1989). Sodium has the tendency of affecting the taste of water meant for consumption when its concentrations are above the threshold limits. Aluminum content was 0.02-0.06 ppm. Manganese ranges between 0.02 and 0.08 ppm in the water samples, well below the guideline value of0.50 ppm. Aluminium can cause water staining, though it might not have any adverse health effects, while large quantity of manganese influences taste in water and encourages the growth of bacteria; though not hazardous but are very unpleasant (Leticia *et al*, 2009; Goyer 1991). Generally, all the water samples had low mineral contents below WHO stipulated limits hence, these water samples may not constitute health risks to consumers and the general public.

Table 3.Mineral elements in well water from some private households in Falegan area of Ado Ekiti, Ekiti State

Water Sample										
Metals (Ppm)	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**010**
Pb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fe	ND	0.06	0.03	0.02	0.02	ND	0.02	0.03	0.03	0.02
Ar	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Al	0.04	0.02	0.02	0.06	0.02	0.04	0.02	0.02	0.04	0.02
Cu	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mg	58	51	58	44	38	54	52	48	50	46
Zn	0.2	0.4	0.4	0.8	0.2	0.6	0.2	0.1	0.3	0.4
Ca	96	74	68	70	62	68	82	74	86	92
Na	80	72	58	72	76	68	72	64	78	72
K	53	45	36	55	54	50	52	48	54	52
Mn	0.08	0.04	0.02	0.06	0.04	0.02	0.04	0.06	0.04	0.02
Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ni	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

***** ND: Not detected

Microbial properties of water from hand dug, ringed and covered water wells from some private households in Falegan, Ado Ekiti, Nigeria

Table 4 shows the result of microbial parameters of well water samples from Falegan in Ado Ekiti town. The total plate count ranged between 2-5Cfu/ml, which is within WHO acceptable limits (10^2cfu/ml). Previous studies suggested that the spread of diseases through pollution and faecal contamination of water particularly in developing and underdeveloped countries is common (Orebiyi *et al*., 2010; Narasimha *et al*, 2014; WHO, 2013; Shimizu *et al*, 2009).

Table 4.Microbial properties of well water from some private households in Falegan, Ado Ekiti, Ekiti State

Water Sample										
Parameter(Cfu/ml)	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**010**
Tot. viable count	2	4	5	3	4	5	4	3	5	4
Presumptive test	-Ve	-Ve	-Ve	-Ve	-Ve	-Ve	-Ve	-Ve	-Ve	-Ve
Coliform count	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

**** -Ve: Negative

Presumptive test was negative in all the tested water samples, indicating that all the samples had no gas producing organisms. Coliform bacteria was not detected in any of the water samples, implying that the water samples had no faecalcontamination, which is acceptable for human domestic use (Bonde, 2004; Adegoke, 2000).

The total viable count in treated drinking water is a measure of its general sanitary quality whereas the indication of faecal contamination in water is measured by the presence of faecal coliforms. WHO/NIS limits is that none should be detected in drinking water (Orebiyi *et al*., 2010; WHO 2013).This clearly indicated that the well water are of good microbiological quality, and thus suitable for human consumption.

Conclusion

Water, a vital resource is essential for life. In most underdeveloped countries, industrial and domestic activities have threatened the purity of water supplies mostly through the indiscriminate discharge of pollutants into water bodies with serious and potentially hazardous environmental and health implications. Increasing global population means adequate safe and potable water must be made available to sustain domestic and industrial uses, hence there is a constant need to ensure that minimum standard requirement for potable water quality is attained and obtainable at all times.

The physicochemical, elemental and microbial properties of all the water samples evaluated in this study were within standards as specified by W.H.O for potable water and fit for domestic applications. However, adequate and effective water treatment must be periodically undertaken to ensure the quality of water from these water wells and safeguard public health.

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