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Physicochemical Characteristics and Trace Metal Levels of Locally Dug Wells in Tunga Area of Minna, Nigeria

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ABSTRACT: Physicochemical characteristics and trace metal levels of water from locally dug wells in Tunga area of Minna were studied using titrimetric and instrumental methods. Trace metal levels in all the studied wells ranged between 0.40-1.50, 0.32-0.95, 0.12-0.50, 0.03-0.21, 0.01-0.04 and 0.01-0.02mg/L for Cu, Fe, Zn, Cr Pb and Cd respectively. The physic-chemical parameters like temperature, dissolved oxygen, conductivity and total dissolved solids gave average values of 27.9°C, 3.89mg/l, 22.62mg/l, and 15.8mg/l respectively. The average concentrations of chlorides, total hardens magnesium and calcium ions analysed were 34.58mg/l, 147.63mg/l, 7.99mg/l and 114.90mg/l respectively. Results from this study showed that the industrial and human activities in this study area pose no major health hazard to their well water, and are therefore fit for their domestic activities. Notwithstanding, regular monitoring of trace metal levels in these wells which act as major sources of water for their domestic activities need to be carried out by regulatory bodies due to the increasing human population in this area. @JASEM.

Key words: Dissolved oxygen, conductivity, concentration, total dissolved solid, total hardness.

The quality of water depends on the management of anthropogenic discharges as well as the normal physicochemical characteristics of the catchment areas (Efe et al 2005). Some trace elements are essential to man, but at elevated concentrations, essential and non essential elements can cause morphological abnormalities, reduce growth, increase mortality and mutagenic effects (Nkono and Asubiojo (1997), Asaolu (2002), Davis and Jixiang, (2000), Adeyeye and Abulude (20004) and Adeyeye and Ayejuyo (2000).

Good drinking water quality is essential for the well being of all people. It plays an important role in bodily intake of essential elements by man (Abulude et al, 2007). Unfortunately, in many Countries around the world, including Nigeria, drinking water supplies have become contaminated with some toxicants which has imparted on the wealth and economic status of the populations. As a result of inadequate treatment and disposal of waste (human and livestock), and industrial discharges, contaminants such as bacteria, viruses, heavy metals, nitrates and salts have found their way into water supplies (Sorabjeet and Luke, 2003).

Underground water has remained the major sources of drinking water in most rural and some urban cities of the world. Due to human and industrial activities, various types of wastes are discharged to the environment. These waste products of industrial activities and urban run-off find their ways into this underground water, thereby contaminating it with some toxic metals. This was highlighted in Bangladesh were natural levels of arsenic in ground water was found to be causing harmful effects on the population (Anawara et al, 2002).This problem of pollution of ground water and it subsequent effect on man arose because most ground water are extracted for drinking and for domestic use without pre-treatment or any detailed chemical investigation on its composition.

Interest in water analysis is due to the enormous importance of water to all categories of living things. According to Abulude et al (2007), developing countries are witnessing changes in ground water which constitute another sources of portable water. In this work some locally dug wells in Minna metropolis were analysed in order to ascertain their extent of contamination by human activities since they act as major sources of water for their domestic activities instead of the modern pipe borne water that is scarcely obtainable in the metropolis.

MATERIALS AND METHOD

Sampling areas: - Water samples from twelve different locally dug wells in Tunga area of Minna were used for this study. The choice of this area for the study was due to its widely populated human density and activities. The general topography of the studied area is of rocky terrain.

Sampling: **-** Care was taken during sampling to minimize any external contamination of the samples with metals. This is very important for trace metal analysis as there are many metal containing materials (e.g. dust, car exhaust particles, rust) on the field and laboratory that may contaminate samples.

Sampling method reported by Sarabjeet et al (2003) was adopted. The sample bottles (polyethene) were washed with detergent; cleaned and rinsed with distilled water, then filled with 1% Trioxonitrate (v) acid solution and stored in a sealed plastic bag. At the sampling sites, the acid was removed; the bottles rinsed three times with sample prior to filling.

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The sample was filled into the sampling bottles after rinsed, capped and return to the plastic bag. Clean powder-free latex hand gloves were worn during sample collection. Upon return to the laboratory, samples collected were acidified with Trioxonitrate (v) acid to reach a concentration of 0.4v/v and stored in a refrigerator at a temperature of 40^{o}C prior to analysis. Because very little visible particulate matters were present in the sample. Filtering was not considered necessary and therefore no further sample digestion was performed.

The following physicochemical properties were determined in the samples; temperature, pH, conductivity, taste, odour, dissolved oxygen, turbidity, total dissolved solutes, hardness, calcium, magnesium and chloride ions.

Analysis: **-** Using standard methods (APHA, 1976), the pH was measured with a pH- meter, dissolved oxygen with a DO meter. Conductivity with conductivity, turbidity measure with a turbidity meter total dissolved solids were measured using a conductivity meter and the total dissolved solids were obtained by multiplying the conductivity by a factor of 0.64. The total hardness magnesium and calcium were measured by EDTA titrimetric using Erichrome black T indicator, while the Chloride was obtained by Mohr titration methods.

Atomic absorption spectroscopy (Buck model 20 VGP) model was used for the analysis of the pre-treated samples for the following trace metals-Fe, Cu, Zn, Cr, Pb and Cd which are among the nine (9) listed toxic metals by the United State Environmental Protection Agency (1998) with the exception of Fe.

All laboratory equipments (auto sampler clamps, pipette and glassware) that were used for the sample analysis were acid cleaned in 10% Trioxonitrate (v) acid and rinsed several times with deionized water prior to use.

RESULTS AND DISCUSSION

The results of some physicochemical parameters in the locally dug well water of the studied area are shown in table 1. The appearance and odour detected were found to be clear and unobjectionable in all samples. The temperatures of the samples ranged between 27-30 ^{o}C, while pH ranges from 6.40-8.10, with W6 having the lowest and W8 the highest. W6 which is within the mildly acidic pH range may have been due to dissolution of some particulate matters from anthropogenic sources. The pH obtained from the various water samples studied are in line with the desirable pH of 7.0-8.5 recommended by World Health Organization for drinking water (WHO, 1990).

Dissolved oxygen (DO) ranged from 2.56 to 4.74 mg/l. The dissolved oxygen concentration showed that the samples were oxygen-rich, which agree with the fact that most of the wells were open- wells.
The total dissolved solids which are an indication of the degree of dissolved substances such as metal ions in the water were found to be in the range of 14.08 - 7.28 mg/l. While the turbidity level of all the samples were found to be zero.

The degree of hardness of the water was high and this might limit the dissolution of the heavy metals (Adeyeye and Ajeyugo (2002). This may have been responsible for the absence of some of these heavy metals in some of the water samples and low level of conductivity obtained (Abulude et al, 2007).

Adeyeye and Abulude (2004) reported that the hardness of water can be classified as soft water if it has a hardness range of 0-75mg$CaCO_3$/l, as hard water if it has a hardness range of 75-150mg $CaCO_3$/l and over 350mg $CaCO_3$/l as very hard water. While Sarabjeet and Luke (2003, reported that water having a hardness of between 35-120 mg $CaCO_3$/l can be classified as medium hard water. Based on the above results, most of the studied water samples can be classified as hard water since their hardness fell within the range of 103-247 mg$CaCO_3$/l with the exception of two wells with hardness of 51.54 mg $CaCO_3$/l and 66.96 mg $CaCO_3$/l respectively. The total concentration of divalent metal ions, primarily calcium and magnesium expressed in mg/l of equivalent $CaCO_3$ which is termed as total hardness were in the range of 40.10-192.40mg/l (mean of 198,23mg/l) and 2.80-13.39mg/l (mean of 8.00mg/l) respectively, These metal ions fell with the maximum acceptable limit recommended by WHO for drinking water (WHO, 1996). The appreciable concentration of Ca and Mg were consistent with the level of hardness because higher value of Ca and Mg were consistent with the total hardness of the water samples. Chlorides were in the range of 11.50-64.00mg/l (mean of 64.58mg/l). Chlorides are relatively harmless to organism except when converted to Cl_2 and ClO_3 which are toxic.

Table 1: Physicochemical properties of water from various well. UB = unobjectionable; CL = Clear

Parameters	W_1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W_{11}	W_{12}
Appearance	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
Odour	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB	UB
Temperature (^{0}C)	27.0	27.0	28.0	27.5	27.5	29.5	30.0	27.0	28.0	27.5	27.0	29.0
pH	7.50	6.98	6.55	6.91	6.50	6.40	8.10	6.75	6.60	7.10	6.90	7.50
DO (mg/L)	4.41	4.74	3.33	4.21	4.30	2.78	2.56	4.62	3.09	5.02	4.73	2.94
Conductivity (µs/cm)	23	25	27	26	25	26	25	25	24	25	24	22
TDS (mg/L)	14.72	16.0	17.28	16.64	16.0	16.64	16.00	15.68	15.36	16.00	15.36	14.08
Turbidity (NTU)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Calcium (mg/L)	184.4	40.1	92.20	140.3	52.1	80.20	116.2	92.20	108.1	112.2	168.3	192.4
Magnesium (mg/L)	12.83	2.80	6.42	9.77	3.63	5.58	8.10	6.42	7.52	7.81	11.72	13.39
Total hardness (mg/L)	273.00	51.64	118.33	180.33	66.96	103.00	149.38	118.50	138.93	144.24	216.35	247.00
Chlorides (mg/L)	37.00	64.0	53.00	20.00	53.5	38.50	17.00	11.50	24.50	34.00	29.00	33.00
Nitrate (mg/L)	1.02	0.85	0.65	0.75	1.04	0.95	0.78	0.64	0.50	0.68	0.80	0.58

Note: W_1-W_{12} = Different wells from which water samples were collected

From the analysis carried out to determined the following trace metals, Cu, Fe, Zn, Cr, Pb and Cd using AAS (Buck model 20 VGP), it was observed that the metal ion concentrations in the different wells were generally low. The trace metal levels in all the studied wells (Table 2), ranged between 0.40-1.50, 0.32-0.95, 0.12-0.50, 0.03-0.21, 0.01-0.04 and 0.01-0.02mg/L for Cu, Fe, Zn, Cr Pb and Cd respectively, with W_9 and W_{10} having the highest cumulative metal ion concentration of 1.95mg/L and well W_2 the least with 0.99mg/L respectively. For all the samples studied, the parameters were all within the WHO guidelines for drinking water and some below detectable limits indicating that the water has very low level of trace metals. This therefore, suggests that there was low risk of solubility of metals in the water. This also goes to suggest that the industrial and human activities in this area have not impacted so much toxic substances in the wells. The low metal ions concentration may have been due to the depth of our studied wells which were not too deep. This may have also contributed to the low detection of some of these trace metals in some of the water samples since the studied wells were between 6-14metres deep, which is in line with Ifabiyi (20008) findings that there exist a correlation between the depth of a well and the quality of water derived therein. He went further to state that the deeper the depth of a well the higher the concentration of the metal ion content in the well water. The cumulative burdens of metal ions were highest in well W_9 and W_{10} where they have artisan welders and least in $W_{2,}$ where they have no commercial activity going on.

Table 2: Trace metal content of the different locally dug wells

Parameters	*W_1*	*W2*	*W3*	*W4*	*W5*	*W6*	*W7*	*W8*	*W9*	*W10*	*W_{11}*	*W_{12}*	*Min.*	*Max.*
Cu	*0.40*	*0.50*	*1.50*	*1.06*	*0.85*	*0.75*	*0.92*	*1.20*	*0.80*	*0.70*	*0.53*	*0.80*	*0.40*	*1.50*
Fe	*0.50*	*0.32*	*0.45*	*0.72*	*0.34*	*0.65*	*0.38*	*0.63*	*0.95*	*0.85*	*0.68*	*0.35*	*0.32*	*0.95*
Zn	*0.20*	*0.15*	*0.18*	*0.30*	*0.50*	*0.20*	*0.35*	*0.45*	*0.12*	*0.36*	*0.45*	*0.18*	*0.12*	*0.50*
Cr	*0.10*	*0.09*	*0.08*	*0.07*	*0.05*	*0.10*	*0.03*	*0.04*	*0.05*	*0.04*	*0.07*	*0.21*	*0.03*	*0.21*
Pb	*0.01*	*0.04*	*ND*	*0.03*	*0.02*	*0.01*	*ND*	*0.03*	*0.02*	*ND*	*0.03*	*0.02*	*NN*	*0.04*
Cd	*0.01*	*ND*	*ND*	*0.02*	*0.01*	*0.02*	*ND*	*ND*	*0.01*	*ND*	*0.02*	*0.01*	*ND*	*0.02*

Note: W1-W12 = Different wells from which water samples were collected; Min. and Max. = Minimum and maximum concentrations of each trace metal in all the wells; ND = Not detected

Con*clusion:* This study has shown that the physicochemical and trace metals content of water from these locally dug wells are all within the WHO guidelines for drinking water quality and therefore pose no health risk problem to the user. Thus the water can be recommended as an acceptable source for their domestic uses. In order to assess the health risk arising from drinking this water regular monitoring of their trace metals content should be carried out due to the increasing human population in this area.

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