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Determination of Physico-chemical Parameter and Trace Metal Contents of Drinking Water Samples in Akure Nigeria

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Abstract: The physico-chemical and trace metal contents of water samples from Akure, Nigeria were assessed using atomic absorption spectrophotometery. Results indicated that low variation existed among some physico-chemical parameter (pH, temperature, conductivity, dissolved oxygen and nitrate). In the water sample oil and grease, taste and odor were not detected. The mean levels (mg L^{-1}) of the metals ranged thus; 4.8(Fe), 0.3 (Cr), 0.1(Cd), 0.2(Pb), 0.2(As), 0.1(Ni). However, Co and Zn were not detected. Comparison of the metal contents in the water sample with WHO limits showed that the mean levels of all the metals were below the maximum permissible levels for drinking water.

Key words: Physico-chemical parameters, trace metals, drinking water, WHO limits, Nigeria

Introduction

Interest in water analysis is due to the enormous importance of water to all categories of living things. It is necessary for the healthy development of man, animals and plants. Developing countries are witnessing changes in ground water which constitute another source of portable water. The preference for ground water to surface water must be due to the purification of the latter prior to distribution (Adeyeye and Abulude, 2004). Although it is easily accessible from lakes, rivers streams and springs, but borehole water are of better quality.

Drinking water plays an important role in the bodily intake of true element by human. Even through some trace elements are essential to man, at elevated levels essential as well as non essential element can cause morphological abnormalities: reduce growth increase mortality and mutagenic effects (Nkono and Asubiojo, 1998; Asaolu, 2002; Adeyeye, 2000). The toxicity of metals is dependant on their solubility and this in turn depends on pH and on the presence of different types of anions and other cations. Water pollution has been a subject of active investigation for a long time. Interest in this has grown because of the perceived hazardous effects of trace element.

The aim of the study was to report on the assessment of the physico-chemical parameters and the trace metals present in the drinking water sources earmarked for this study. It is hoped that the results would add to the existing data.

Materials and Methods

Water samples were obtained from Federal College of Agriculture, Akure Nigeria premises in March, 2005. Four water sample each were obtained from different source in plastic containers cleaned with acid and labeled thus: UP1-Upper dam water, LO2- lower dam water, Rad3,- rain water(direct source), Raa4- rain water (from Asbestos roof), Ras5-Rain water (from zinc roof), BO6-Borehole water, We7-Well water and Ro8-rockwater.

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The following physico-chemical properties were determined immediately after sampling: Temperature, pH, conductively, taste, odor, oil and grease and dissolved oxygen. pH was measured with a meter (Hanna instruments, model 8621) and conductivity measured with a JSI model 33 conductivity meter after standardizing with KCL and NaCl solutions. Various standard methods (APHA, 1976) were used for others parameters. Chloride by Mohr's method, total hardness by EDTA titration using erichrome Black T indicator.

For the metal analysis, the water samples where acidified with nitric acid. A 100 cm^3 aliquot of the sample was digested with HNO_3 in a beaker at 120°C until a clear solution was obtained (Abulude, 2005). All the sample were then stored at 40°C in the refrigerator prior to analysis. The samples were analyzed for Fe, Cd, Cr, Pb, As, Ni, Co and Zn. Using a Perkin Elmer model 306 atomic absorption spectrophometer. All assays were carried out at last four times. Means, standard deviation and coefficient of variation (%) of all the value were calculated.

Results and Discussion

The temperature of the sample ranged from 24.3 to 27.4°C. pH was in the range of 3.3 to 8.2 while conductivity ranged from 310 to 461 mhos cm^{-1} (Table 1). The highest desirable level for pH is within the range of 7.0-8.5 (WHO, 1990). The agricultural activities of the area where the samples were taken did not alter the pH of the water samples. The degree of hardness of the water was low and this might encourage the dissolution of heavy metals (Adeyeye and Ayejuyo, 2002). This may explain the presence of most of the metals in the water samples and the high level of conductivity (Ipinmoroti *et al*., 1997). Taste and odors were not detected in any of these samples. Water has been classified on the basis of hardness as follows (Adeyeye and Abulude, 2004): water having 0-75 mg $CaCO_3$ L^{-1} as soft, 75-150 mg $CaCO_3$ L^{-1} as hard while samples having vtotal hardness of over 300 mg $CaCO_3$ L^{-1} was hard. Based on these, the water samples in this study fell under soft water. The present result compared with the result of Adeyeye and Abulude (2004) on ground and surface water samples. The total concentration of divalent metal ions (primarily Ca and Mg) expressed in mg L^{-1} of equivalent $CaCO_3$ is termed total hardness of water. Mg and Ca were in the range of 0.4-7.3 mg L^{-1} (mean; 3.6 mg L^{-1}) and 3.4-30.0 mg L^{-1} (mean, 17.4 mg L^{-1}), respectively. These metals fell within the maximum acceptable limit by WHO. The presence of appreciable concentration of Ca and Mg were consistent with the level of hardness because higher values of Ca and Mg were consistent with total hardness.

Chloride was in the range of 1.0-30.2 mg L^{-1} (mean, 10.6 mg L^{-1}). Samples from low dam and rock have highest chloride content than those from other source. The entire water sample was not

Table1: Physico chemical parameters of samples

Parameter	UP1	$L0_2$	Rad_3	Raa_4	Bos_5	Bo_6	We_7	Ro_8	Min	X	Max	SD	CV (%)
Temp °C	25.2	25.8	24.8	24..3	24.3	27.4	27.0	24.8	24.3	25.5	27.4	1.19	4.67
pH	7.4	7.4	7.6	7.3	7.3	7.6	7.4	8.2	7.3	7.5	8.2	0.30	3.94
Conductivity (mhos/cm)	324.0	461.0	310.0	420.0	328.0	380.0	315.0	405.0	310.0	367.0	461.0	56.79	15.44
Taste	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO
Odour	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO
Chloride (mg L^{-1})	6.8	24.8	1.0	1.9	2.1	7.2	10.3	30.7	1.0	10.6	30.7	11.16	105.2
Magnesium (mgL^{-1})	6.2	7.3	0.8	0.9	0.4	6.0	1.20	5.8	0.4	3.60	7.3	2.98	83.36
Calcium (mg L^{-1})	12.0	28.6	3.4	4.8	4.7	30.3	25.7	30.0	3.4	17.4	30.0	12.33	70.76
Total hardness ('')	57.6	42.5	40.7	43.4	41.7	38.8	48.1	61.3	38.8	48.8	61.3	8.33	17.82
D/O (mg L^{-1})	10.7	8.77	8.60	7.40	9.20	11.20	15.2	18.2	7.4	11.20	18.2	3.71	33.25
Nitrate (mg L^{-1})	1.08	1.02	0.90	0.07	0.21	0.43	1.01	6.60	0.07	1.30	6.61	1.30	165.9
Oil and grease	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF

Up1- Upper dam water, $L0_2$-lower dam water, Rad_3-Rain water, Raa_4-rainwater (Asbestos), Ras_5- Rain water (Zinc roof), Bo_6-Borehole water, We_7-Well water, Ro_8- Rock water, NF-No visible floating, D/O-Dissolved oxygen polluted. Chlorides are relatively harmless to organisms except when converted to CL_2, CLO-and CLO_3-which are toxic. High chloride content impacts taste and could cause corrosion (WHO, 1990).

Dissolved oxygen ranged from 7.4 to 18.2 mg L^{-1}. The dissolved oxygen concentration of the samples showed that the samples were oxygen-rich although, rain water obtained from asbestos roof had the lowest value. The values were not highly varied. This is depicted by the value of CV (%), 33.25. The nitrate values ranged between 0.07 and 6.6 mg L^{-1}. The results showed that all samples have low nitrate values. Nitrate in natural waters can be traced to percolating nitrate from sources such as decaying plant and animal materials, agricultural fertilizers, domestic sewage (Adeyeye and Abulude, 2004).

A nitrate content of more than 100 mg L^{-1} impact bitter taste to water and may cause physiological problem. Drinking water contains more than 50 mg L^{-1} nitrate can cause methamoglobinemia in infants (Uba and Aghogho, 2001). Nitrate causes the overgrowth of algae, other organism and fouls the water system. Epidemiological studies have predicted association between exposures to nitrate and gastric cancer because of the reaction of nitrate with amine in diet forming carcinogenic nitrosomoamines.

There was no visible floating in the water sample indicating absence of oil and grease. The level and range of the elements in the water sample are shown in Table 2. The distribution diagram of each metal was prepared to evaluate the variability of each metal contents (Table 2). In all the samples, the mean level of all the elements were below the WHO limits. The range of Fe, Cr, Cd, Pb and As, were 3.3-6.1, ND-0.2, 0.1-0.3 and ND-0.2 mg L^{-1}. Co and Zn were not detected. The concentration range of the metal indicate a lack of uniform distribution of metal within the water sample, however same variations of this magnitude have also been reported by other workers (Obodo, 2002, 2004; Nkono, 1997). The variation observed were probably due to various factors such as trace metal contents of all the soil and crops, geographical location, fertilizers and fungicides applied in the area, environmental pollutions due to automobile emissions, industrial effects, other agricultural activities and weathering of rocks.

The total weekly intake of Pb and Cd through food, water and air established by WHO are 3500 and 525 μg per person, respectively (WHO, 1990). Although the metal contents were below these levels, however regular monitoring of the metal pollution of these areas should be enforced so that there would not be any increase in the total weekly intake of these metals above tolerance levels.

It is obvious that the levels of Fe, Cd and Pb were higher than those recorded in countries outside Nigeria. The level of Co and Zn were higher than the values for this study. However, the result for As and Ni where in total agreement with this study. The higher content of Cd and Pb may be related to the vehicular traffic density and the use of leaded gasoline (Table 3).

Heavy metal poising particularly lead and cadmium have been reported to give rise to quite a numbers of chemical syndromes for example Cd accumulation is associated with hypertension, osteomalacia and itai-itai disease. Lead poisoning has been found to be associated with permanent brain damage, behavioral disorders and impaired hearing (Asaolu, 2002).

Table 2: Trace mineral content (mg L^{-1}) of water sample (n = 4)

Parameter	UP_1	Lo_2	Rad_3	Raa_4	Ras_5	BO_6	We_7	Ro_8	Min	X	Max	SD	CV%
Fe	6.1	5.9	3.5	4.3	4.5	3.3	5.4	5.1	3.3	4.8	6.1	1.04	21.8
Cr	0.3	0.1	0.2	0.1	0.5	0.4	0.1	0.3	0.1	0.3	0.5	0.15	60.5
Cd	0.1	0.2	-	0.1	-	0.1	0.1	0.1	-	0.1	0.2	0.04	35.0
Pb	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.3	0.1	0.2	0.3	0.07	45.8
As	0.1	0.2	-	0.2	-	0.2	-	0.1	-	0.2	0.2	0.06	38.5
Ni	-	-	0.2	-	-	-	-	-	-	0.1	0.2	0.06	43.3
Co	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND = Not Detected

Table 3: Comparison of elemental levels (mg L^{-1}) in drinking water samples of other countries with that of Nigeria

Element	Present study	Southern Nigeria	Pakistan	USA	Norway	Britain
Fe	3.3-61	-	0.00-0.04	-	-	-
Cr	0.1-0.5	0.12-0.11	0.00-4.10	-	-	0.4-0.15
Cd	ND-0.2	0.05-0.06	0.00-1.12	-	<0.25	0.0-0.06
Pb	0.1-0.3	0.21-0.44	0.60-4.20	0.83	<0.35	0.0-0.07
As	0.0-0.2	0.24-1.30	-	-	-	0.04-0.05
Ni	ND-0.2	0.44-1.10	0.00-1.20	-	<0.15	0.08-0.17
Co	ND	-	-	-	-	-
Zn	ND	-	1.10-4.30	-	5.09	0.12-3.81

Conclusions

This study has shown that the entire water sample meets the WHO limits for the trace metals and the physico- chemical properties. It means that water is not polluted. However, regular monitoring should be ensured by the authorities concerned.

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