



Comparative Study of Selected Heavy Metal and their Physico-Chemical Characteristics in Different Sources Of Water

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ABSTRACT

This study evaluates the comparative study of selected heavy metal and physico-chemical characteristics in borehole water, well water, bottled (table) water and sachet water in selected places around Apata-Adabeji, Ibadan, Oyo state. Nine (9) samples were analyzed which are three (3) bottled (table) water samples (A-C), two (2) sachet water samples (D-E), two (2) well water samples (F-G) and two (2) borehole water samples (H-I). Water qualities parameters examined were pH, Alkalinity, Conductivity, Total hardness, Total Dissolve Solid (TDS) and some metals; Calcium (Ca), Phosphate (P), Lead (Pb). Metal concentration analysis was done with the aid of Atomic Absorption Spectrophotometer (AAS) and the physicochemical parameters were measured using standard method. The result was compared against drinking water quality acceptable standard. The study showed selected physicochemical and heavy metals analysis are in accordance with permissible standards of World Health Organization (WHO) and Standard Organization of Nigeria (SON), but having some heavy metals analyzed in the water samples below WHO and SON standard while some water samples are above standard limit of WHO and SON in water samples of Pb in sample (A), Fe in sample H and Mn in sample F. Lead and Manganese were not detected (ND) in samples B, C, E. Zinc ranged from (0.008-0.035), Lead ranged from (0.02-0.044), Iron ranged from (0.002-0.034), manganese ranged from (0.001-0.059). The result showed selected heavy metals and physicochemical parameters analyzed in all the water samples except for Pb in sample A, Fe in sample H and Mn in sample F was not contaminated and within permissible limit, therefore water is safe for use.

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1.0 Introduction

Water as a universal solvent. It is an essential to man for various domestic, industrial and agricultural purpose. Chemically, it is a diatomic substance of two (2) hydrogen and a single atom of Oxygen, with a chemical formular H_2O (Anon, 2005). The quality of water is of great importance and a key factor considered in it sourcing and processing. Living organisms requires trace amount of some heavy metals, including cobalt, copper, iron, manganese. Excessive level of essential metals, however, can be detrimental to living organisms (Nollet, 2000). Water is considered safe for use if it is free from contaminants and has properties within recognized quality acceptable standard (WHO, 2015). High level concentration of heavy metals in water act as contaminant which accumulate in the body, thus causes harm to the organs, due to it been highly poisonous and toxic to the anatomy and physiology of living organisms (Dissmeyer, 2000). Some of these heavy metals are lead (Pb), arsenic (As). Heavy metals are introduced into water bodies from various activities such as mining, chemical manufacturing, residues from agricultural inputs, municipal effluent and other anthropogenic processes. Anifewoso and Oyeboode (2019)., Antico *et al* (2017). Physicochemical parameters are on the values of various physicochemical qualities in water sample. A number of scientific procedures include the analyses of different parameters such as pH, alkanility, total dissolved solid amongst others. These parameters can affect the quality of drinking water if values are in higher concentration than the acceptable limits of WHO and SON (WHO, 2011). This research examined the contaminants level of selected heavy metals residues and physicochemical characteristics in selected water samples of different sources in Adabeji - Apata, Ibadan, Nigeria environment, thereby comparing them with the acceptable standard permissible limits of the WHO and SON.

2.0 Materials and Methods

2.1 Description of study area

Water samples were collected in the vicinity of Adabeji-Apata, Ibadan, Nigeria at selected sources of water which includes: well water, borehole water, bottled (table) and sachet water samples.

2.2 Sampling and analytical procedures

Water samples collected from two borehole sites, two sachet water from different water company, two different well- water source and three different most popular bottled (Table) water. The water samples collected were stored as prescribed by American Public Health Association APHA (APHA, 1998) methods. They were further preserved in the refrigerator before laboratory evaluation.

2.3 Digestion procedure

25mL of water sample was measured using measuring cylinder, 10mL of concentrated nitric acid was then added. The water sample was heated on a hot plate for about one hour with intermittent shaking every ten minutes interval. The digested water sample was filtered and topped till it reached calibrated mark with digested water. It was corked and shook very well before transferring into the sterilized sample bottle and labeled for instrumental analysis.

Analysis of water sample was done using physical analytical equipment, some chemical analysis was done by titrimetric method and data were presented as mean.

2.4 Determination of physicochemical parameters of samples

Water samples pH were determined using the pH meter (model 600). Conductivity meter (model hanna 911) was used to determine their conductivity. Total dissolved solid (TDS) was determined by multiplying conductivity by 0.53 (Dinsifo *et al.*, 2010). Total hardness were determined using Eriochrome Black T indicator and titrated with 0.01M EDTA. Alkalinity, magnesium, calcium and phosphate was determined with standard methods.

2.5 Metal analysis of samples

Water samples used for the analysis were acid preserved and prior to the analysis well digested. The metals analysed for were Zinc, Lead, Iron, Manganese. Analysed metals was done with the aid of atomic absorption spectrophotometer (AAS) Bulk Scientific VGP 210 model.

3.0 Results and Discussion

Heavy metals analysed in table 1 were zinc, (Zn), lead (Pb), iron (Fe), manganese (Mn) in borehole water, well, bottle (table) and sachet water shown the mean level of heavy metals concentration in water samples in which some of the analysis conformed with the requirement of WHO and SON standards.

Zinc (Zn) in sample A-I falls below the WHO and SON Standards which range from (0.008-0.035). With the WHO and SON Standard level of (5.00 and 3.00) respectively; the highest and least Zn values of 0.033 - 0.008 were recorded in sample (I) borehole water and sample (C) bottled (table) water. However, there was no significant difference ($p>0.05$) in the values of Zn obtained from the water samples.

Results for Lead (Pb) below the WHO and SON standards were sample F,G,H. Samples, B,C and E were not detected, but samples I, A and D respectively (borehole, bottle and sachet water) were above the WHO and SON standards ranging (0.02-0.044). The highest and least values of 0.02 and 0.002 of bottled (table), sachet water and well water of water samples A, D and G. However, there was no significant difference ($p>0.05$) in the values of Pb obtained from the water samples.

Iron (Fe) in all samples A- I were below the WHO and SON standards except for sample H (borehole water ranges above the WHO and SON standard. Fe ranged from (0.001-0.034). The highest and least values of 0.034 and 0.001 of borehole and bottled (table) water, water samples H and C. However, there was no significant difference ($p>0.05$) in the values of Fe obtained from the water samples.

Manganese (Mn) in the samples (A,C) bottled water, (D) sachet water sample, (G) well water sample and (H, I) bore hole water sample, were below the WHO and SON Standards except in the sample F well water which was above WHO and SON standards and also not detected in samples B and E. Mn range from (0.001-0.059). The highest and least values of 0.01 and 0.001 of bottled (table) water samples A and C. However, there was no significant difference ($p>0.05$) in the values of Mn obtained from the water samples.

Table 1: Mean level of heavy metals in water samples (mg/l)

Sample	Zn	Pb	Fe	Mn
A	0.032	0.02	0.011	0.01
B	0.015	ND	0.022	ND
C	0.008	ND	0.001	0.001
D	0.035	0.02	0.004	0.015
E	0.015	ND	0.01	ND
F	0.021	0.0021	0.012	0.059
G	0.025	0.002	0.010	0.026
H	0.022	0.003	0.034	0.002
I	0.033	0.044	0.004	0.004
WHO (2011)	5.00	0.010	0.30	0.050
SON (2007)	3.00	0.010	0.030	0.050

BDL – Below Detected Limit, WHO – World Health Organization, SON – Standard Organization Nigeria.

The results on table 2 below represent the mean level of the physicochemical parameters determined in water samples were pH, alkalinity, total hardness, total dissolved solid. pH in samples A-I were within the WHO and SON Standard which range from (6.18-7.20). The highest and least values of 7.20 and 6.18 of sachet and well water of water samples D and G respectively. However, there was significant difference ($p>0.05$) in the values of pH obtained from the water samples.

Total Dissolved Solid (TDS) in sample A-I are within the permission limit of WHO and SON Standards, It ranges from (30.0-530). The highest and least values of 530 and 30.0 of sachet and bottled (table) water of water samples D and B. However, there was significant difference ($p>0.05$) in the values of TDS obtained from the water samples.

Total Hardness (TH) in sample A-I is all below WHO and SON Standards. In sample B and E, it is below detection limit (BDL), samples ranges from (35.0-115).The highest and least values of 115 and 35.0 of borehole and bottled (table) water, water samples H and A. However, there was significant difference ($p>0.05$) in the values of TH obtained from the water samples.

Alkalinity in all samples was all below WHO and SON Standards. Some were below detected limited (BDL) for samples B and E, with samples range from (3.0-19.0). The highest and least values of 19.0 and 3.0 of borehole and sachet water, water samples H and D. However, there was significant difference ($p>0.05$) in the values of alkalinity obtained from the water samples. All samples analyzed were clear, colourless, tasteless and odourless.

Table 2: Mean level of physicochemical parameter in water samples.

Sample	pH	TDS(mg/)	TH(mg/)	Alkalinity
A	7.03	140	35.0	12.0
B	6.35	30.0	BDL	BDL
C	6.70	110	BDL	3.3
D	7.20	530	49.67	3.0
E	6.27	40.0	BDL	BDL
F	6.71	320	112.67	17.5
G	6.18	170	96.67	10.0
H	6.40	120	115	19.0
I	6.20	250	57.0	9.50
WHO(2011)	6.5-8.5	1000	150	150
SON (2007)	6.5-8.5	500	150	150

Keywords: TDS – Total Dissolve Solid, TH – Total Hardness, BDL – Below Detection Limit

The results in table 3 show the mean level of selected chemical parameters in water. Conductivity in all samples falls below WHO and SON standards which ranges from (20.1-247.9).The highest and least values of 247.9 and 20.1 of borehole and bottled (table) water, water samples H and B. However, there was significant difference ($p>0.05$) in the values of conductivity obtained from the water samples.

Calcium in samples B and E are below detection limit (BDL) and other samples (A, C) bottled water, (D) sachet water sample, (F,G) well water sample and (H, I) borehole water sample below the WHO and SON Standards ranges from (10.00-26.67). The highest and least values of 26.67 and 10.00 of borehole and bottled (table) water, water samples H and A. However, there was significant difference ($p<0.05$) in the values of calcium obtained from the water samples.

Magnesium (Mg) analyses has samples D, F, H and I below the WHO and SON Standard and samples F, H, I above the SON Standard. Samples B, C and E are below detection Limit (BDL), Samples ranges from (0.19-0.26). The highest and least values of 0.26 and 0.19 of borehole and bottled (table) water, water samples I and A. However, there was significant difference ($p < 0.05$) in the values of magnesium obtained from the water samples.

Phosphate analyses has the highest and least values of 0.74 and 0.001 of sachet and bottled (table) water, water samples D, E and C. However, there was significant difference ($p < 0.05$) in the values of phosphate obtained from the water samples.

Table 3: Mean level chemical parameters in water samples

Sample	Conductivity ($\mu\text{s}/\text{cm}$)	Calcium (mg/l)	Magnesium (mg/l)	Phosphate (mg/l)
A	93.8	10.00	0.19	0.62
B	20.1	BDL	BDL	0.35
C	73.7	13.00	BDL	0.29
D	234.5	10.33	0.21	0.74
E	26.3	BDL	BDL	0.74
F	214.4	26.63	0.24	0.37
G	247.9	18.83	0.19	0.30
H	224.4	26.67	0.22	0.41
I	167.5	14.67	0.26	0.42
WHO (2011)	2000	150	5.00	NA
SON (2007)	1000	100	0.20	NA

Keywords: BDL – Below Detected Limit
 ND – Not Detected
 NA – Not Available

4.0 Conclusion

The physicochemical and heavy metal analysis of various water samples from different sources in Adabeji - Apata, environs Ibadan, Nigeria indicates that the physical parameters such as appearance, taste and pH conformed to acceptable standards. Most of the physicochemical properties such as conductivity, total hardness, total dissolved solids and heavy metals such as manganese (Mn), zinc (Zn), lead (Pb) and iron (Fe) analysis conformed to the permissible limit except for Pb in sample A, Fe in sample H and Mn in sample F which were higher than the standard limit. Comparatively, water samples quality follows the trend: bottled water > sachet water > borehole water > well water. This study reveals that not all the water samples are contaminated with heavy metals.

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