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Analysis of Physicochemical Parameters and Heavy Metals In Drinking Water from Boreholes and Wells in Dutse district, Jigawa State, Nigeria

***Tahir M.T, Abdulmalik S., Suleiman A.K**
Department of Chemistry, Federal University Dutse, Jigawa State, Nigeria

ABSTRACT

The levels of some physicochemical parameters and some selected heavy metals from boreholes and wells water were assessed in Dutse District area of Jigawa. Samples were collected randomly from different sampling sites and were analyzed using standard methods of analysis. The result shows that pH had a mean level of 7.8 ± 1.45, conductivity mean level was 532.4 ± 28.64 MSCM-1. The mean total hardness was 160.5 ± 0.7, Turbidity had a mean level of 1.7 ± 0.22 NTU, chloride had a mean level of 69.91 ± 21mg/l and total dissolve solid TDS had a mean of 292.9 ± 21.14mg/l. heavy metals analyzed include copper, chromium, lead, nicked and zinc using Hitachi Z – 8100 Atomic absorption spectrometer and their mean levels are 0.31 ± 0.2mg/l, 0.11± 0.01mg/l, 0.14 ± 0.007mg/l, 0.20 ± 0.007mg/l and 0.09 ± 0.002mg/ls respectively. The result indicates that the physicochemical parameters and the heavy metals are within the maximum allowable levels set by WHO and NDWQS 2011.

Keywords : Physicochemical Parameters, Heavy Metals, Borehole Wells, Dutsedistrict.

I. INTRODUCTION

Water is one of the most important and abundant natural resources in which all living organisms on the earth depends for their normal survival and growth.[1] Different types of harmful contaminants find their ways into the water and make it unsuitable and unsafe for both drinking and domestic purposes, and this is as a result of increased human population, industrialization, agricultural practices and manmade activities. Therefore, it is necessary that the quality of drinking water should be checked at regular intervals, because continuous use of contaminated water causes the spread of varieties of water borne diseases. [1]

Water pollution is a major global problem which requires ongoing evaluation and revision of water resource policy at all levels [2]. It has been suggested that it is the worldwide cause of deaths and diseases and that it accounts for the deaths of more than 14000 people daily [2].

The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. Natural water contains different types of impurities which are introduce into aquatic system by different ways such as weathering of rocks and leaching of soils, dissolution of aerosol particles from the atmosphere and from several human activities including mining and other activities from processing industries. [3].

II. METHODS AND MATERIAL

All the reagents used in this research are of analytical analar grade and all the glass wares were cleaned and rinsed with detergents and immersed in 25% nitric acid and finally rinsed with deionized water.

2.1Sampling

A total of 10 samples of water were collected out of which 6 samples were from boreholes and 4 from wells in different areas of Dutse District of Jigawa State. The samples were collected in triplicate in clean polyethene plastic containers. The pH and conductivity were determined immediately after sampling and the samples were stored at a temperature below 4^{0c}. The sampling was conducted in between 20^{th} – 204^{th} April, 2017.

2.2 Study Area

Dutse is a city in north western Nigeria, it is the capital city of Jigawa State and it is located in Nigerian map between latitude: $11^{0}45'$ 22.5"N and longitude: $9^{0}20'$, 20.26"E. Dutse has a population of 153,000 (2009 census) with a 3 digit postal code prefix of 720. [18]

III. Methodology

3.1pH Measurement

The pH was measured using – pH meter (Model HI 4358) after the pH meter was switched on and allowed to warm for about 5minutes and standardized with a buffer solution, it was then immediately introduced into the water sample and the measurement was taken. The electrode was then rinsed with deionized water before another measurement [4].

3.2Conductivity Measurement

Conductivities of the water samples were measured using a digital conductivity meter. The meter was switched on and then standardized using 0.1N kcl at 25^{0c}. The electrode was then immersed into the water sample and conductivity reading of each sample was recorded [5]

3.3Turbidity Measurement

The turbidity of the water samples was measured using a digital turbidity meter (). The meter was standardized with clean deionized water. The turbidity reading of each sample was then recorded. [6]

3.4The Determination of Total Dissolved Solid

The total dissolved solid was determined using a conductivity meter, the programming of the conductivity meter, the programme menu of the conductivity meter was switehed to total dissolved solid, $100cm^3$ of the sample was measured into the beaker and the electrode was introduced into the sample. The 3.5Determination results of to dissolved solid were displayed and recorded [4]

3.5 Determination of Total Hardness

$10cm^3$ of water sample was pipetted into a conical flask. 1cm3 of buffer solution (NH_4CL) of PH=10 and 3 drops of erichrome black T indicator were added to the flask. The mixture was then titrated with 0.01M EDTA (ethylene diammine tetra acetic acid) until the colour changed from wine red to blue the procedure was repeated two more times to obtain the average litre value [7]

3.6Determination of Chloride

50ml of the water sample was taken in a clean conical flask and 0.5ml of potassium chromate was added followed by shaking and the mixture was titrated with silver nitrate as a titrant [8]

3.7Determination of Heavy Metals

About 5ml of concentrated hydrochloric acid was added to 250ml of each water sample and evaporated to 25ml. the concentrate was filtered using a cellulose membrane (0.45mm)and transferred to a 50ml flask

and diluted to mark with distilled water.[7] Heavy metals (Cu, Cr, Pb, Ni and Zn) ware determined using atomic absorption spectrometer (Hitachi Z - 8100) . The values obtained were expressed in mean ± standard deviation.

IV. RESULTS AND DISCUSSION

The results of the selected physiochemical parameter and some of the heavy metals analyzed in both the boreholes and wells drinking water from the various sampling site in Dutse district have been presented in table 2, 3 and 4 respectively, in the form of mean ± standard deviation.

Table 1: Sampling sites and their ID

S/N	Sampling Sites	I.D Code
1	RafinSanyi	A
2	GidaDubu	B
3	Bokkoto	C
4	FUD Male Hostel	D
5	Tsohuwar Cinema	E
6	Takur	F
7	Garu	G
8	Zai	H
9	Limawa	I
10	FUD Female Hostel	J

Table 2: Mean levels for PH, conductivity and Turbidity for water samples

S/N	Sampling Sites	PH	Conductivity ($ms/(cm^2)^1$)	Turbidity (NTU)
1	RafinSanyi	7.4±0.14	758±14.5	2.20±0.011
2	GidaDubu	7.6±0.10	640±42.3	2.10±0.012
3	Bokkoto	6.8±0.15	420±32.3	3.35±0.016
4	FUD Male Hostel	7.6±0.17	400±29.5	1.74±0.013
5	Tsohuwar Cinema	7.1±0.12	620±39.2	1.40±0.015
6	Takur	6.1±0.11	600±21.2	1.30±0.002
7	Garu	6.3±0.13	346±22.3	1.22±0.013
8	Zai	7.2±0.16	480±42.3	1.30±0.021
9	Limawa	7.3±0.17	560±21.5	0.67±0.021
10	FUD Female Hostel	7.2±0.16	500±22.3	1.68±0.014

Table 3. Mean Levels for total hardness, chloride and TDS for water samples.

S/N	Sampling Sites	Total Hardness	Chlorides mg/l	TDS (mgl)
1	RafinSanyi	171±15.3	96.1	220.3±14.5
2	GidaDubu	164±13.2	48.1	200.2±2.5
3	Bokkoto	160±15.3	57.6	423.2±12.4
4	FUD Male Hostel	182±2.4	73.6	400.2±13.5
5	Tsohuwar Cinema	196±0.32	44.8	240.2±23.4
6	Takur	154±0.11	48.4	320.1±32.2
7	Garu	142±2.23	112.3	230.3±12.5
8	Zai	119±11.03	67.7	452.3±30.1
9	Limawa	132±3.04	60.3	132.4±20.1
10	FUD Female Hostel	184±14.2	70.2	320.3±30.2

Table 4. Mean levels for copper, chromium, lead, nicked and zinc of the water samples

S/N	Sampling Site	Cu	Cr	Pb	Ni	Zn
1	RafinSanyi	0.18±0.002	0.04±0.013	0.18±0.002	0.23±0.001	0.08±0.002
2	GidaDubu	0.27±0.011	0.07±0.023	0.18±0.015	0.08±0.012	0.05±0.004
3	Bokkoto	1.18±0.023	0.11±0.007	0.17±0.003	0.30±0.023	0.11±0.003
4	FUD Male Hostel	0.27±0.045	0.14±0.010	0.03±0.012	0.15±0.004	0.19±0.002
5	Tsohuwar Cinema	0.18±0.023	0.03±0.032	0.15±0.003	0.23±0.003	0.08±0.001
6	Takur	0.36±0.032	0.07±0.014	0.16±0.012	0.15±0.006	0.09±0.003
7	Garu	0.09±0.026	0.13±0.001	0.17±0.004	0.23±0.004	0.05±0.001
8	Zai	0.18±0.013	0.20±0.003	0.09±0.012	0.34±0.003	0.12±0.005
9	Limawa	0.31±0.014	0.14±0.002	0.16±0.005	0.15±0.002	0.08±0.001
10	FUD Female Hostel	0.14±0.011	0.13±0.002	0.04±0.003	0.13±0.007	0.06±0.002

V. DISCUSSION

The results of PH levels in the various water sample were presented In table 2, the result showed that all the sampling sites had PH level Falling within the W.H.O, N.P.W.D.R and NSDWR recommended range value of 6.5-8.5 [9][10]. With exception of sampling sites at Takur and Garu in which the PH level was found to be 6.1 and 6.3 which are slightly below the recommended level set by WHO. This could be attributed to acid rain, sewage, industrial waste dumping through leaching into the soil which ultimately increases the soil acidity and consequently lowered the pH. [11]

In general, the conductivity measurements showed that all the sampling sites have conductivity lower than the maximum level of 1200mscm^{-1} set by the W.H.O. [9] and 2500mcm^{-1} set U.S.EP.A. This could be attributed to less accumulation and leaching of dissolved inorganic solid materials. [12]
The highest and lowest conductivities are 758$\pm$14.5 and 346 $\pm$ 22.3 recorded in Rafinsanyi and Garu respectively.

Higher level of turbidity is associated with disease causing bacteria, suspended materials due to soil run off etc. [14]. The turbidity recorded in all the water samples are within the recommended level of 5 NTU as set by WHO and NDWQS for drinking water [15, 16]

Based on the classification of water by [13] in terms of softness and hardness i.e. 0 – 60mg/l soft, 60 – 120mg/l moderately soft, 121 – 180mg/l moderately hard and above 180 is hard, the water samples analysed are considered to be hard but safe for drinking and other domestic purposes. But the hardness could be removed by simple boiling or addition of chemical e.g. washing soda, or sodium hydroxide etc.

Total dissolve solid is due to the presence of dissolve salts which consequently causes undesirable taste, gastrointestinal irritation etc. According to the result all the sampling sites have TDS levels lower than maximum allowable level set by W.H.O and NDWQS of 1000mg/l [16]. The highest TDS value of 452mg/l and the lowest TDS value of 132mg/l correspond to samples from Limawa and Zai respectively [Table 3]
The chloride ions determined in all the samples from the sampling points are below the maximum level of 250ppm set by WHO, Indian standards and US, EPA guidelines. [17] The highest chloride values of 112.3mg/l and the lowest chloride values of 44.8mg/l were recorded for samples from Garu and Tsohuwar Cinema respectively [Table 3].

5.1Heavy Metals

The presence of heavy metals in drinking water higher than a certain concentration especially the well-known set standards can cause a serious health hazards to human beings and other living organisms. Therefore, the analysis of heavy metals in drinking water is very important in order to ascertain the quality of drinking water. The results of heavy metals analysis of Cu, Cr, Pb, Ni and Zn [Table 3] indicate that their concentrations are within the safe limits set by WHO and NDWQS, which indicate that both the boreholes and wells are not polluted with heavy metals. The heavy metal concentrations are in the order Cu>Ni>Pb>Cr>Zn.

VI. CONCLUSION

The values of the physicochemical parameters determined (pH, conductivity, Turbidity chloride and TDS) from all the water samples i.e. both the boreholes and wells water in the sampling site in Dutse district were found to be within the recommended limits of WHO and NDWQS. The concentrations of the heavy metals (Cu, Cr, Pb, Ni and Zn) were also measured and found to be well below the standard maximum concentrations. Therefore, the water in the sampling sites are safe for both drinking and other domestic purposes.

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