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ASSESSMENT OF SOME HEAVY METALS AND PHYSICOCHEMICAL PARAMETERS IN HAND-DUG WELL AND BOREHOLE WATER SAMPLE FROM MUBI SOUTH L.G.A ADAMAWA STATE

Muhammad Abubakar[1,*] and Ibrahim Tajo Sirajo[2,]

[1]Department of Science and Technology Education, Bayero University, Kano. PMB 3011. Kano-Nigeria

[2]Department of pure and Industrial Chemistry, Faculty of Physical Science, Bayero University Kano. PMB 3011 Kano-Nigeria

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ABSTRACT

An attempt has been made to detriment the concentration level of some heavy metals and physicochemical parameters in hand-dug Well and Borehole water of Mubi local government area of Adamawa state with the aid of AAS, pH and conductivity meter. Water samples were collected from ten sites which serves as drinking water sources and subjected to analysis for determination of Pb, Cd and Cr. The result shows equal concentration of Pb (0.048±0.00 mg//L) detected from three samples, the concentration level of Cd and Cr ranges between 0.088 to 0.439 mg/L and 0.250±0.165 to 0.750±0.333 mg/L respectively, this indicate that all the three heavy metals detected were above the standard limit set by WHO and SON for drinking water. pH, conductivity and TDS values ranges between 6.94 to 8.14, 362 to 1063 µS/cm and 199.10 to 584.65 mg/L respectively, these were less than the value set by WHO.

Keywords: Heavy Metals; Physicochemical Parameters; Water; Mubi; Adamawa.

Author Correspondence, e-mail: mabubakar.ste@buk.edu.ng

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1. INTRODUCTION

1.1. Water

Water is a transparent fluid which forms the world's streams, lakes, oceans and rain, is also said to be the major constituent of the fluids of organisms. As a chemical compound, a water molecule contains one oxygen and two hydrogen atoms that are connected by covalent bonds (H_2O) [1]. It is the most abundant compound on Earth's surface, covering 70 percent of the planet [2]. Although all of the world's population has access to water sources, water that is available in several locations is often not safe, sufficiently affordable or available in sufficient quantities to meet the basic health needs [3]. Water pollution is a major problem facing the world which requires frequent evaluation and water resources policy review at all levels (international down to individual aquifers and wells). Research has shown that, polluted water causes deaths and diseases worldwide, it accounts for the deaths of more than 14,000 people daily [4]. The rate of discharge of pollutants into the environments which ultimately find their ways into the water bodies, is higher than the rate of purification. This was due to rapid urbanization, industrialization and growing population. Natural Phenomena such as volcanoes, algae blooms, storms, and earthquakes also cause major changes in water quality and the ecological status of water [5]. Generally, water is not pure as it acquires contaminants from its surrounding and those arising from humans and animals as well as other biological activities [6]. One of the most important environmental issues today is ground water contamination, between the wide diversity of contaminants affecting water resources, heavy metals receive particular concern considering their strong toxicity even at low concentrations [7].

1.2 Heavy Metal

Any metallic chemical element such as Hg, Cd, As, Pb, Cr, Sn etc that has a relatively high density above 5 g/cm^3 and is toxic or poisonous at low concentration is referred to as heavy metals [8,9]. These metals may find their ways into water sources through sewage, agricultural activities, industrial waste, municipal solid waste and other natural activities [10,11]. The adverse health effects of heavy metals in humans depends on their dosage, rate of emission and period of exposure. They affect almost all body organs and causes brain damage, lungs and kidneys cancer, gastrointestinal bleeding, cardiovascular blockage, high blood pressure or heart rate, vomiting and diarrhea; skin rashes and eye irritation [12].

Lead is the most common environmental pollutant found in the air, soil and water unlike other metals, it has no any biological role and potentially toxic to microorganism [13], exposure to lead can occur through inhalation of contaminated dust containing lead and aerosols or contaminated food substances and water. Lead poisoning in humans damages the kidneys, liver, heart, brain and the nervous system [14], exposure to metal like Cadmium may cause cancer of the lung, kidney and prostate and damages of respiratory, renal, skeletal and cardiovascular system [15], the first symptoms of the effect is usually a tubular dysfunction or damage, acute pulmonary problem, sporadic case [16]. Chromium may enter into water through industrial discharge as chromium salts are used extensively in many industrial processes such as metal finishing plating application, anodizing aluminum, manufacture of paint, dyes, explosives, ceramics and tannery [12], Chromium exist in water in four valence states Cr^{2+}, Cr^{3+}, $Cr^{5+}$and Cr^{6+}, the most toxic and carcinogenic is hexavalent Cr^{6+} including the chromates of Ca, Zn, Sr, and Pb while the trivalent form rarely occurs in potable water [17], It has also been reported that Chromate compounds can destroy DNA in cells of living organisms [18].

This research work aimed at providing information for the concentration level of some heavy metals and other physicochemical parameters emanating from human activities and other environmental pollutants in hand-dug Well and Borehole water in Mubi south Local Government Area of Adamawa state Nigeria.

2. EXPERIMENTAL

2.1 Material

All chemicals and reagents used were of the analytical grade and were obtained from BDH Chemicals Ltd, UK. Concentrated nitric acid was used for the digestion of the samples. Soluble salts of Lead, Cadmium and Chromium were used for preparation of Lead, Cadmium and Chromium standards solutions respectively.

2.2 Sample Location

Mubi south local government is the second largest city in Adamawa state Nigeria which comprised of 129,956 people [19], it is geographically located within Latitude of 10.1874 (10°11'14.64" N) and Longitude of 13.39576 (13°23'44.74" E) with an altitude of 592 m above sea level [20], It has a total land area of 414 (sqkm) with mountainous topographic land, the area has a tropical climate marked by dry and rainy seasons with the average rainfall of 79mm.

2.3 Sample Collection

Samples were collected from five different hand-dug wells and five different boreholes water using a clean 1000 ml plastic containers. The new plastic gallons were washed and rinsed with water sample prior to collection, the sample was preserved with concentrated nitric acid before digestion [21].

Table 1. Sample code and name of the area located

S/N	Sample Code	Located Area
1.	WW1	Wuro Patuji
2.	WW2	Monduva
3.	WW3	Gella
4.	WW4	Sebore
5.	WW5	Kasuwan Barkono
6.	BW1	Mujara
7.	BW2	Ngavahi
8.	BW3	Gude
9.	BW4	Fillin Ball
10.	BW5	Kolere

Key: WW= Well water BW= Borehole water

2.4 Sample Digestion

100 ml of water sample was transferred to a beaker and followed by addition of 5.0 ml concentrated nitric acid, the solution was placed on a hot plate and evaporated to 20 ml, the beaker containing the residue was allow to cooled at room temperature, another 5.0 ml $HN0_3$ was added and gently heated for five minutes and allow to cool at room temp. The resultant solution was filtered through Whatman No. 1 filter paper to remove silicate and other insoluble materials, the volume were made up to 100 ml with distilled water and then subjected to A.A.S machine for the determination of heavy metals concentration [22]. Flame Atomic Absorption Spectrophotometer (Buck Scientific 210 VGP Model) was used for the analysis of digested water samples and blank solution for determination of Lead Cadmium and chromium metals, using appropriate lamp for each metal [23].

2.5 Physicochemical Parameters

The pH of the samples was measured using an electric digital pH meter (Jenway 3510 pH meter), the measurement of electrical conductivity was performed with the aid or conductivity meter (Jenway 430 model conductivity meter) and the total dissolved solids of water sample were determined using the relation below:

$TDS = K_E(EC)$

Were K_E is the correlation factor which varies between 0.55 to 0.8, EC is the electrical conductivity measured in micro Siemen per centimeter, and TDS is the Total dissolved solids measured in mg/L [24].

3. RESULTS AND DISCUSSION

3.1 Heavy Metals

The mean concentration of Lead, Cadmium and Chromium metals in mg/L of the digested water sample were calculated and presented in Table 2 below.

Table 2. Mean Concentration Level of Pb, Cd and Cr in Water Sample

Sample code	Pb (mg/L)	Cd (mg/L)	Cr (mg/L)
WW1	0.048±0.00	0.439±0.198	0.500±0.083
WW2	ND	0.263±0.022	0.250±0.167

WW3	ND	0.175±0.066	0.250±0.167
WW4	ND	ND	0.500±0.083
WW5	ND	ND	0.250±0.167
BW1	0.048±0.00	0.439±0.198	0.500±0.083
BW2	0.048±0.00	0.263±0.022	0.250±0.165
BW3	ND	0.088±0.153	ND
BW4	0.048±0.00	0.088±0.153	0.750±0.333
BW5	ND	0.175±0.066	0.500±0.083
SON[25] WHO[26]	0.010	0.003	0.050
Mean	0.048	0.241	0.417
SD	0.000	0.310	0.444

Key: WW= Well Water BW= Borehole water SD= Standard deviation

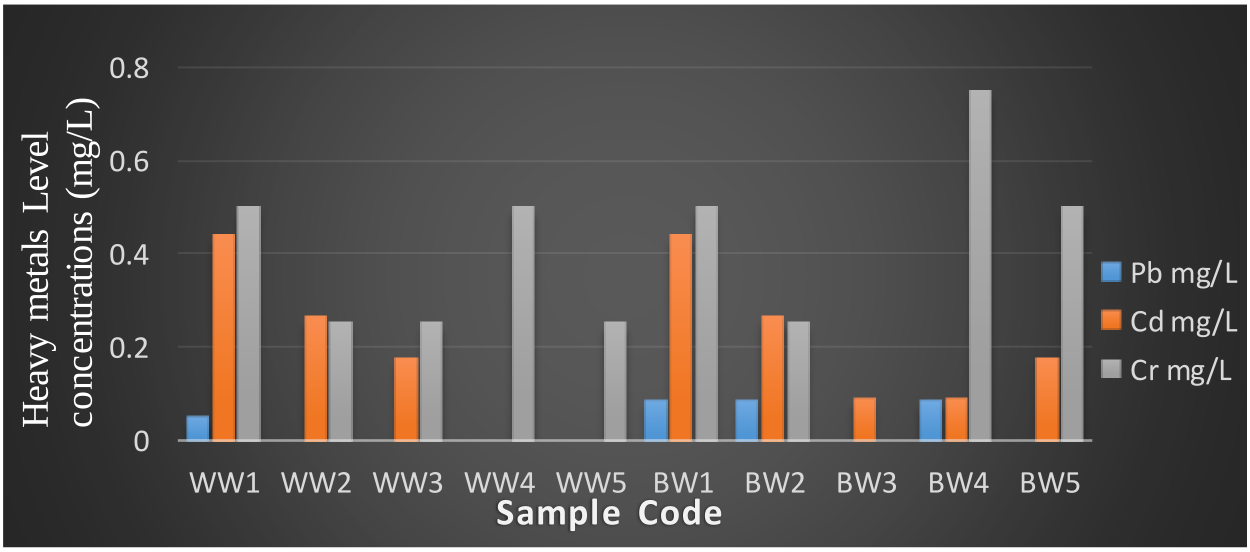

Fig.1. Mean concentration level of Pb, Cd and Cr in all the water sample

For the protection of human health, guidelines for the presence of heavy metals and contaminants in water have been set by different national and international organizations such as WHO, USEPA, EPA, SON, etc, and recommend that the properties of every drinking water should fall within the acceptable limit set by it. Thus, heavy metals have maximum contaminant level [mcl] which is enforceable standard set at numerical values with an adequate margin of safety to ensure no adverse effect on human health [27].

The mean concentration of Lead in all the samples was analyzed, the results in Table 2 indicates that WW1, BW1, BW2 and BW4 contained lead in equal concentration 0.048±0.00 mg/L, the acceptable limit for lead concentration in portable drinking water is 0.01 mg/L as set by world health organization [26]. Lead detected in those areas could be linked to agricultural activities, gold mining which occurred around BW1 sample sites. Domestic sewage and other form of human activities in the surroundings at the particular period of investigation, which also vary from one location to another could be a reason associated to metal accumulation [27]. However, lead were not detected in the remaining six samples, its absent does not really mean that the water was free from lead metal it could be obtainable in trace concentrations below the detection limit of the analytical instrument [28], exposure to lead, even in low concentrations results in several health effects on body organs and system including brain, kidneys, gastrointestinal tract, thyroid gland and reproductive system [11,29]

The results for mean concentration of cadmium in Table 2 indicates that cadmium concentration ranges between 0.088 to 0.439 mg/L, sample WW1 and BW1 have the highest mean concentration of cadmium in equal amount 0.439±0.198 mg/L while sample BW3 and BW4 have the lowest Cd mean concentration in equal volume 0.088±0.153 mg/L, cadmium was not detected in sample WW4 and WW5. The acceptable limit for cadmium concentration in drinking water as set by standard organization of Nigeria and world, health organization is 0.003mg/L [25,26]. Therefore, concentration of cadmium in eight of the samples detected were found to be above the threshold limit, this could be attributed to number of environmental factors in those areas that leads to water pollution and contamination by heavy metals. The existence of cadmium and lead in drinking water is considered as a key pathway of potential exposure to toxicity in many countries [30]. Chromium was analyzed in all the samples and the results obtained in Table 2 revealed that the mean concentration of Cr ranges between 0.250±0.165 to 0.750±0.333 mg/L, WW2, WW3, WW5 and BW2 have the lowest mean concentration in equal amount (0.250±0.165 mg/L), this concentration was doubled in WW1, WW4, BW1 and BW5, the highest concentration of chromium was detected in BW4. The acceptable limit for chromium in drinking water was measured by standard organization of Nigeria to be 0.05mg/L [25]. Thus, concentration of chromium in all the samples except BW3 was found to be above the limit set by standard organization of Nigeria. Natural and agricultural activities, improper domestic waste and sewage sludge could be linked to leaching and infiltration of Cr into portable drinking water sources, Exposure to this metal (especially Cr^{6+}) by living organisms can lead to numerous health effects such as lung cancer, nerve tissues, skin ulcers and irritation, malignant neoplasia, damage of liver, kidney, circulatory disorder [12].

3.2 Physicochemical Parameters

The physical assessment of color, odour and taste of the water samples collected in Mubi South, has shown that all the water sample appeared to be clear, colorless, odorless and tasteless. Table 3 presents the results for pH, Electrical conductivity (EC) and Total dissolved solids (TDS) measured.

Table 3. Mean values of pH, Electrical conductivity (EC) and Total dissolved solids (TDS)

Sample code	pH	EC (µS/cm)	TDS (mg/L)
WW1	7.46	475.00	261.25
WW2	7.50	362.00	199.10
WW3	6.94	524.00	288.28
WW4	7.36	642.00	353.10
WW5	8.00	1063.00	584.65
BW1	8.14	382.00	211.20
BW2	7.68	412.00	226.60
BW3	7.40	519.00	285.45
BW4	7.09	602.00	331.10
BW5	7.21	376.00	206.80
SON[25], WHO[26]	6.5 - 8.5	1000.00	500.00
Mean	7.48	536.70	294.75
SD	0.89	443.03	243.26

Key: WW = Well water, BW = Borehole water, SD = standard deviation

The results for pH value as shown in Table 3, ranges between 6.94 to 8.14, this indicate that all the sample have a pH within the threshold limits (6.5 to 8.5) set by world health organization [26]. The highest pH value was obtained in the borehole water sample (BW1) and the lowest pH value was obtained in the well water sample (WW3). These results indicates that all the ten samples analyzed were free from acidic and basic environmental pollutants. Electrical conductivity measurement result presented in Table 3 ranges between 362 to 1063 µS/cm, the lowest EC value (362.00 µS/cm) was found in WW2 and the highest conductivity value (1063.00 µS/cm) was obtained in WW5, this high value could be associated to aqueous dissociation of ions in the sample due to high number of contaminants (soluble salts) that produces ionic species, the ions dissociated in water increase both the conductivity of water and the amount of dissolved solids [31]. Research has shown that the EC of good city water is 50 µS/cm, absolute pure water 0.055 µS/cm and drinking water 0.5 to 1 µS/cm [32] The acceptable limit for conductivity of drinking water should not exceed 1000 µS/cm [25]. Therefore, all the water sample except WW5 has EC values within the threshold limit set by standard organization. Total dissolved solids obtained in the water samples ranges from 199.10 to 584.65 mg/L. The lowest TDS value was found in WW2 and the highest value was obtained in WW5, this shows that WW5 has high number of suspended solids compared to other samples measured. The estimation of the amount of TDS contents in water sample is based on EC measurement [33], EC gives an indication of the amount of total dissolved solids (TDS) in water sample, as more salts are dissolved in water, EC value became higher [34,35]. The acceptable limit for total dissolved solids in drinking water should not exceed 500 mg/L [25,26]. Therefore, all the water samples except WW5 (584.65 mg/L) have TDS value within acceptable limit as recommended by various standard organizations.

4. CONCLUSION

Determination of some selected Heavy metals and physicochemical parameters in hand-dug Well and Borehole water obtained from Mubi South local Government area of Adamawa State was conducted. The results of the analysis shows that the concentration level of lead detected in four of six samples, Cadmium detected in seven of ten samples and that of chromium detected in nine of ten samples were found to be above the standard limit of 0.01, 0.003 and 0.05 mg/L respectively as set by standard organizations [25,26]. Physicochemical parameters revealed that pH values for all the sample are within the threshold limit set by WHO, except in sample WW5, the conductivity measured in μS/cm and total dissolve solids values in mg/L are within the acceptable limits of 1000 μS/cm and 500 mg/L respectively [25,26]. Generally, it could be inferred that the underground water assessed from Mubi south may not be suitable for human consumption as the level of Lead, cadmium and chromium metal may pose some health Hazards and hence the need for proper measures.

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