Assessment of physicochemical parameters of some heavy metals; Lead Chromium, Copper, Zinc, and Iron in Borehole and hand dug - well water: A case study of Fika Local Government Area, Yobe State, Nigeria

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Abstract: **This study aimed to determine the physicochemical parameters in some selected borehole and dug well water within Fika local government area, Yobe State. Ten (10) sample were collected, two (3) Borehole water and seven (7) Hand dug - well water from different locations and were cleaned in plastic container sealed and transported immediately to the laboratory for analysis. Heavy metals were analyzed using AAS (Atomic absorption spectrophotometer). From the experimental result it shows that the concentration of Cu, Pb, Zn, Cr and Fe in the samples all conformed to the requirement of WHO, NSDWQ and SON standards. But the concentration of cadmium (Cd) in all the samples exceeds the limit. The physical parameters such as pH, conductivity were conformed to be within the standard limit except turbidity which exceeds the limit in sample (DWC, DWD, DWE, BHF, DWH and DWJ). It is concluded that all the Hand dug well water samples are not absolutely good for drinking as stipulated by WHO. It is also recommended that the sources of borehole water required frequent treatment to meet the standard for portable drinking water. Therefore, people should use the Borehole water often than the hand - dug well water as regard to areas without doubt.**

Keywords; **Physicochemical; Borehole; Dug well; heavy metal; AAS**

I. INTRODUCTION

Water is the most crucial and precious natural resources, it is very important in the life of all living organism, plant and microorganism to the most complex living system known as human body (Ojo et al., 2005). Water of good quality is significant to human physiology and man's continued existence depends very much on its availability (Lamikanra, 1999).Water a combination of hydrogen and oxygen atoms, with a chemical formula H_2O and known to be the most abundant compound at about seventy percent (70 %) on earth surface. it is significant due to its unique chemical and physical properties (Obi et al, 2004).

Therefore, water supplied system for peoples intake neither must not surround by pathogens, germs, or harmful/toxic chemicals because water which when adulterated such with microorganism can cause epidemics (a wide spread outbreak of an infectious disease). I.e. good drinking water is not a luxury but one of the most vital requirement of life itself. (WHO, 2006).

According to World Health Organization (WHO, 2006) revealed that 75% of all diseases in the developing and under developed countries such as Nigeria arise from polluted drinking water (either from borehole or dug - well , therefore, water quality concerns are often the most important component for measuring access to improved water sources (boreholes and dug wells). Standard quality shows the safety of drinking water in terms of its physical and chemical limitations. The problems associated with chemical constituents of drinking water arise primarily from their ability to cause adverse health effects after prolonged periods of exposure, of particular concern are contaminants that have cumulative toxic properties such as heavy metals and substance that are carcinogenic. The most common problem in household water supplies (water from boreholes and dug wells) may be attributed to the presence of PH, EC, turbidity, zinc, lead, copper, iron, chromium, and cadmium (Mahmud et al, 2008).

II. MATERIAL AND METHOD

Materials

The following materials were used for the study:

- Atomic Absorption Spectrophotometer (AAS).
- Concentrated nitric acid (HNO_3).
- Colorimeter.
- Measuring cylinder
- Volumetric flask
- Beaker.
- Reagent bottles.
- PH Meter.
- Test tube.

- Thermometer.
- Turbidity meter.
- Water sample.

Sampling Study Area

Fika is a local government area in Yobe state, Nigeria .Its Headquarters are in the town of Fika in the south of the area at 11°1700"N and 11°18'29 E/11.28333 ^{O}N and 1130806 ^{O}E. It has an area of 2208Km^2 and a population of 136,895 at the 2006 census result. The next easterly line of equal latitude passes through the area close to Fika. The climate is characterized by short wet season (June-October), with high temperature of 30 ^{0}c – 35 ^{0}c throughout the year. The annual rain is usually low with an average of 500mm-1000mm.

Sample Collection

Samples of water were collected from three (3) different boreholes and seven (7) hand dug- wells sited at different location within Fika town and its environments. The sample was collected in a pre-cleaned sample bottles. The bottles were cleaned rinsed a further two or three times with the water sample and then the water sample was taken.

The sample locations are:

- Sample BHA: Borehole water from NYSC camp area.
- Sample BHB: Borehole water from Fukumari area.
- Sample DWC: Dug- well water from Mainari 1 area.
- Sample DWD: Dug- well water from Sirife area.
- Sample DWE: Dug- well water from Bogawuna moi area.
- Sample BHF: Borehole water from Bogawuna Tinja area.
- Sample DWG: Dug- well water from Fukumari area.
- Sample DWH: Dug -well water from Ga- nguzum area.
- Sample DWI: Dug- well water from Korori area.
- Sample DWJ: Dug- well water from Mainari 2 area

Sample Preservation and Storage

The water sample was preserved immediately after collection with nitric acid (HNO_3) in order to avoid precipitation of metals. Clean polyethylene bag was used to tie up the bottle lid to avoid contamination. The sample was stored at 35 ^{0}C in refrigerator prior to the analysis.

III. METHODOLOGY

Analysis of the Samples

P^H

PH values of the water samples were determined using a portable digital pH meter. The meter was switched on and allowed to warm for about five minutes. It was then standardized with two reference buffer solutions. The electrode of the meter was thoroughly rinsed with distilled water after every sample pH determination. The pH values of the samples were displayed on the unit of the meter and were recorded accordingly.

Conductivity Determination

The conductivity of the samples was determined using digital conductivity meter. The power key and the conductivity key of the meter was adjusted and then standardized with 0.001M KCl to give a conductivity value of 14.7 µS/cm at 25 ^{o}C. The electrode was thoroughly rinsed with distilled water and then immersed directly into water sample and each measurement was taken. The probe was thoroughly rinsed with distilled water after each measurement.

Turbidity

The water sample was Measure into a palin test tube to a level mark and, then carefully insert the sample bottle into the meter. Then press the blanking read bottom, after then the device will instruct to insert the sample, after some seconds the result will be displayed on the screen.

Atomic Absorption Spectrophotometer (AAS)

Heavy metals were analyzed using AAS (Buck Scientific, VPG 210) by procedure reported by Oyelola et al., 2008. All the samples were digested and AAS was used to determine the concentration of metals in all the samples. The determination of Pb, Cr, Fe and Cu was carried out by direct aspiration of the water sample into an air acetylene flame. To determine the concentration of each of the parameters in the sample any metal in the samples, a calibration curve of the metal was prepared using aliquots from the standard stock solution of the metals in preparing the working standards. From the calibration curves, the concentration of Pb, Cr, Fe and Cu in the sample was determined. Concentrations of the analytes in mg/ml in the digested samples were obtained by extrapolation from the calibration curve prepared by American Public Health Association (APHA, 1985).

IV. SAMPLE PREPARATION

Preparation of the stock solution and standards

From 1000 PPM solution of the respective metals lead, copper, cadmium, zinc, chromium, iron (Pb, Cu, Cd, Zn, Cr, Fe) a stock of solution of 100ppm of the metals were prepared by diluting 5ml of the standard solution in 50ml volumetric flask making up to the mark with de-ionized water. Ten volumetric flask of 50ml capacity were labeled OPPM, IPPM, 5PPM, 10PPM, 15PPM, 20PPM, 25PPM,30PPM,35PPM,40PPM, respectively 1ml of concentrated HNO_3 was added to each flask 0,1,5,10,12,20,25,30,35,40ppm. And 0.5ml 2-5ml, 1.5ml, 7.5ml, 10ml and 12.5ml of the stock was added to the corresponding flask. The flask are made up to the marked with de – ionized water. And then shake to mix. Then run into AAS machine to obtain the standard absorbance values. The procedure was revealed for all the metals.

V. RESULT AND DISCUSSION

Results

Table 1: The Table Below Shows The Result Of Physical Parameters In The Tested Water Samples And Their Standards.

Samples	BHA	BHB	DWC	DWD	DWE	SON	WHO	NSDWQ
PH	7.0	7.35	6.76	7.02	8.04	6.5-8.5	6.5-9.5	6.5-8.5
Turbidity (NTU)	4.03	2.02	6.78	10.9	11.03	5.0	5.0	5.0
Conductivity µs/cm	-42	-54	-51	-45	57	1000	1000	1000

Samples	BHF	DWG	DWH	DWI	DWJ	SON	WHO	NSDWQ
PH	7.0	8.35	11.76	7.02	10.04	6.5-8-5	6.5-9-5	6.5-8.5
Turbidity (NTU)	13.03	2.02	6.78	1.09	11.03	5.0	5.0	5.0
Conductivity µs/cm	-49	-54	-51	35	-50	1000	1000	1000

Table 2: The Table Below Shows The Result Of Chemical Parameters In The Tested Water Samples And Their Standards.

SAMPLES CONC(Mg/l)	BHA	BH-B	DW-C	DW-D	DW-E	NSDWQ 2007	SON 2017	WHO 2006
Lead	0.005	0.04000	0.009	0.011	0.008	0.01	0.25	0.01
Copper	0.016	0.119	0.026	0.034	0.025	1.0	1.0	1.0
Cadmium	0.001	0.002	0.000	0.001	0.001	0.003	0.003	0.003
Zinc	0.533	3.967	0.850	1.147	0.833	3.0	5.0	3.0
Chromium	0.028	0.209	0.045	0.060	0.044	0.05	0.05	0.05
Iron	0.331	2.464	0.528	0.712	0.518	0.03	0.3	0.3

SAMPLES CONC.(Mg/l)	BHF	DWG	DWH	DWI	DWJ	NSDWQ 2007	SON 2017	WHO 2006
Lead	0.008	0.003	0.016	0.009	0.003	0.01	0.25	0.01
Copper	0.023	0.008	0.048	0.026	0.008	1.0	1.0	1.0
Cadmium	0.002	0.0001	0.001	0.001	0.001	0.003	0.003	0.003
Zinc	0.757	0.250	1.597	0.853	0.277	3.0	5.0	3.0
Chromium	0.040	0.013	0.084	0.045	0.015	0.05	0.05	0.05
Iron	0.470	0.155	0.992	0.530	0.172	0.03	0.3	0.3

VI. RESULT DISCUSSION

From table 1 and 2 above, the results of the physicochemical parameter shows that the mean pH value of all the ten samples ranging from 6.5-to 8.5 in all the samples lies within the permissible level of 6.5-8.5, and conductivity of all the ten samples are all within acceptable limit of the W.H.O, SON and NSDWQ which is (1000 µs/cm).The turbidity of four(4)sample lies within the permissible limit whereas it exceeds the limit in Six(6) sample which are (DWC,DWD,DWE,BHF,DWH and DWJ) 6.78, 10.9, 11.03, 13.03, 6.78 and 11.03.

From table 2 above, the chemical parameters shows that the concentration of Lead (Pb) analyzed in samples BHB, DWD, and DWH (0.0400, 0.011 and 0.016 mg/l) are above the permissible limit of W.H.O, NSDWQ and SON which is 0.01mg/L. However, the concentration of lead in the sample BHA, DWC, DWE, BHF, DWG, DWI, and DWJ which are relatively acceptable and recommended within the acceptable limits of drinking water i.e. 0.01mg/L.

The concentration of Lead in the study area suggests caution as Lead is poisonous element which accumulates in the skeletal structure of both man and animals. It is also an accumulative toxicant that affects the body immune systems and is particularly harmful to young children. Lead in the body is distributed to the brain, liver, kidney and bones. It is stored in the teeth and bones, where it accumulates overtime. Human exposure is usually assessed through the measurement of lead in blood; Lead in bone is released into blood during pregnancy and becomes a source of exposure to the developing fetus.

The concentration of Cu in all the sample (BHA, BHB, DWC, DWD, DWE, BHF, DWG, DWH, DWI, and DWJ) fall within the World Health Organization (WHO), Nigerian standard for drinking water quality (NSDWQ) and SON set standard which is (1.0 Mg/l).Copper is a metal that exists in the environment as a mineral in rocks and soil. It is commonly found at low levels in natural water bodies, Consumption of high levels of copper can cause nausea, vomiting, diarrhea, gastric (stomach) complaints and headaches. Long term exposure over many months and years can cause liver damage or death.

The concentration of Cadmium (Cd) in all the samples (BHA, BHB, DWC, DWD, DWE, BHF, DWG, DWH, DWI, and DWJ) fall within the WHO, NSDWQ and SON set standard which is 0.003 Mg/l. Cadmium and its compounds are highly toxic and exposure to this metal is known to cause cancer and targets the body's cardiovascular, renal, gastrointestinal, neurological, reproductive, and respiratory systems.

Chromium (Cr) concentration from the result revealed that six (6) sample BHA, DWC, DWE, BHF, DWG, and DWI fall within the set standard which is 0.05 mg/l. While sample BHB, DWD, DWH and DWJ (0.209, 0.060, 0.084, and 0.045) showed higher values greater than the WHO, NSDWQ and

SON limit which is 0.05 mg/l. Chromium is a mineral. It is called an essential trace element "because very small amounts of chromium are necessary for human health. And is used for improving blood sugar control in people with diabetes, type 1 and type 2 diabetes, and high blood sugar due to taking steroids and HIV treatments. Chromium (VI) is a danger to human health, mainly for people who work in the steel and textile industry. And also it has an adverse effect on the skin which includes ulcerations, dermatitis, and allergic skin reactions.

Heavy metal such as lead, cadmium, and copper in groundwater have been reported at excessive levels in groundwater due to land fill operations (Lee et al; 1986; Ogundiran and Afolabi, 2008, Longe and Balogun, 2010). These elevated level of copper, cadmium and chromium in groundwater has the potential of causing gastrointestinal disorder, while cadmium is toxic to the kidney, chromium remains on the top list of causing cancer and cancer related disorder.

The concentration of Zinc (Zn) in all the samples (BHA, BHB, DWC, DWD, DWE, BHF, DWG, DWH, DWI, and DWJ) fall within the standard permissible limit of WHO, NSDWQ and SON which is 3.0 Mg/l. Zinc is an essential nutrient and considered to be non-toxic for body growth and development; however drinking water containing high levels of zinc can lead to stomach cramps, nausea and vomiting. Water with a zinc concentration of more than 3.0mg/L may start to be become chalky in appearance with a detectable deterioration in taste (Rand, 1976).

The concentration of Iron (Fe) analyzed in sample BHF, DWG, and DWH are within the range of permissible limits of drinking water as recommended by WHO , NSDWQ which is 0.3 mg/L, but all other samples BHA, BHB, DWC, DWD,DWE, DWH, and DWI (0.331, 02.464, 0.528, 0.470, 0.992, and 0.530) show higher concentration of Iron in which has the potential of giving undesirable taste, staining laundry, metal pipes for reticulation and scaling in pipes (Oyeku et al, 2001). This explain the reddish brown color stain commonly seen on most metal tanks within the study area. High level of Iron in water has been associated with vomiting and cardiac problems. Iron can be treated by allowing the iron to precipitate when water is exposed to air. The ferric hydroxide precipitate is then filtered to have portable water

VII. CONCLUSION

Based on the result obtained, it's concluded that the physicochemical parameters of water such as PH, conductivity, are all accepted for drinking by WHO, NSDWQ and SON. It's found to be that the water in Mainari 1, Sirife, Bogawuna moi, Bogawuna tinja, Ga-nguzum and Mainari 2 are turbid, been found to be above the standard limit. Some of the chemical parameters are found to be within the limit and safe for drinking. The concentration of metals in Cadmium (Cd) zinc (Zn), and copper (Cu) are found to be within the permissible limit of WHO, SON and NSDWQ. It is concluded that majority of hand - dug well water in thus areas are not absolutely safe for drinking. Proper and appropriate treatment should be done according to seasonal variation with respect to the important physicochemical parameters.

REFERENCE

[1] APHA (1985): Standard Methods for the Examination of Water and Wastewater. 19th edition.

[2] Lamikanra, A. (1999): Essential Microbiology for students and Practitioner of Pharmacy, Medicine and Microbiology, 2nd ed. Amkra books, Lagos. Pp 406 - 410.

[3] Lee, G.F., R.A. Jones and C. Ray, (1986) Sanitary landfill leachate recycle. Biocycle, 27: 36 – 38.

[4] Longe E.O. and Balogun M.R.,(2010). Groundwater Quality Assessment near a Municipal Landfill, Lagos, Nigeria. Res. Journal of Applied Science and Engineering Technology, 2(1): 39 – 44.

[5] Mahmoud A. S., Fawzia H A., Cecil Wallac., Adetoun Aboaba, Wenluo Zhang, James H Nance (2008). Chemical, Microbial and Physical Evaluation of Commercial Bottled Waters in Greater Houston Area of Texas. Journal of science Health. Mar; 43(4):335-47.

[6] NSDWQ, (2007). Nigerian Standard for Drinking Water Quality. Nigerian Industrial Standard NIS 554 Standard Organization of Nigeria, pp: 30.

[7] Obi C. L., Bessong P. O., Momba., M. N, Potgieter, N., Samie, A. and Igumbar, E.O. (2004): Profiles of antibiotics susceptibility of bacterial isolate and physicochemical quality of water supply in rural Venda communities, South Africa. Water S. A., 30(4): 515-519.

[8] Ogundiran, O.O and T. A. Afolabi, (2008). Assessment of the physicochemical parameters and heavy

[9] Ojo, O. A., Bakare, S. B and Babatunde, A. O. (2005): Microbial and chemical analysis of potable water in public-water supply within Lagos University, Ojo. African Journal of Infectious Diseases 1(I): 30-35.

[10] Oyeku O.M., Omowunmi O.J., Kupoluyi O.J., Kupoluyi C.F., Toye O.E. (2001): Wholesomeness studies of water produced and sold in plastic sachets (pure water) in Lagos metropolis. Nigeria Food Journal. (19), 63- 69.

[11] Oyelola, O. T. and Babatunde, A. I. (2008): Effect of municipal solid waste on the levels of heavy metals in Olusosun dumpsite soil, Lagos state, Nigeria. International Journal of Pure and Applied Sciences 2(1):17 - 21.

[12] Rand M.C., (1976) Standard method of the examination of water (4th edition) publication officer:American public Health Association Washington DC,20036

[13] SON, (2017) standard organization of Nigeria. Guideline on drinking water quality. Workshop on January 17 -18 Abuja workshop on 14 – 15 February 2007 Lagos, approved on April 16,

[14] WHO, (2006). Guide line for drinking water quality 3rded, Vol 1.Recommendations. *World Health Organization Geneva*