Assessment of Physicochemical Properties of Well-water Samples in Zing Local Government Area of Taraba state. Nigeria.

Andy N. Moses and Silas Ishaku

Department of Chemistry, College of Education Zing, Taraba State, Nigeria.
revandymoses@yahoo.com and labicity1@gmail.com

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Abstract: This study was carried out to assess the physicochemical parameters of hand dug well water samples in the ten political wards of Zing local government area of Taraba state. Sixty different samples were collected in 10 wards between the months of October 2019 to March 2020. The findings showed that, temperature (ºC), PH, electrical conductivity (µs/cm), Total hardness, Total dissolves Solids, Chlorides, Sulphates, Calcium, Magnesium and nitrates concentrations express in mg/l were within the safe limits recommended by World Health Organization (WHO) and Nigeria Standard for Drinking Water Quality (NSDWQ) for a safe drinking water purposes. Whereas turbidity in all the wards were found to be above the 5 NTU except yakoko (2.07NTU) and Monkin A (0.69NTU) wards. Total alkalinity, Phosphates had a high value above the permissible range in all the wards with mean and standard deviations of 182.75±48.8668 and 8.48±4.2339 respectively. Fluorides ion concentrations were above the recommended/permissible values in all the ten (10) wards except Zing A_2 and Monkin B ward. Therefore, it was concluded from the studies that the hand dug well water in Zing can be used for drinking purposes after suitable treatments.

Introduction: Water is life because is a basic necessity for living. One can survives for weeks without food but no one can survive for weeks without drinking water. Water is consumed not only as liquid water ($H_2O_{(L)}$) but also in soft and energy drinks, some food stuffs, fruits and beverages.

Water is described as a universal solvent; it's a polar solvent and is use for multi-purposes such as industries, household and domestic chores, laboratories, market places, worship centers. etc. Because of these reasons, it becomes imperative to assess the quality of water to serve its intended purposes and functions. Potable Water is an essential ingredient for good health and socio economic development of both man and nation (Udom et al 2002).

Water supply is one of the fundamental requirements for human life. The quality of water drawn by households is an important aspect of domestic supplies that influences public health (Howard and Bartram, 2003).

The most managed resource in the world is water [Mohammed S 2017]. Groundwater is generally an excellent source for drinking, cleaning, bathing, irrigation and industrial purposes.

Water is essential to human life. In all its use, quality is the most important term to consider. Quantity of water differs from place to place due to geographical and climate differences of land user. In other hand the quality of water may differ due to pollution from nutrient pollutant flows through disposal of sewage and other urban waste. Physical properties of water include odourless, tasteless, transparent liquid that is colourless in small amounts but exhibits a bluish tinge in large quantities. It is the most familiar and abundant liquid on earth. In solid form and liquid form it covers about 70 % of the earth's surface. It is present in varying amounts in the atmosphere. Most of the living tissues of human beings is made up of water. It constitutes about 92% of blood plasma, about 80 % of muscle tissue, about 60 % of red blood cells and over half of most other tissues. It is also an important component of the tissue for most living thing (Gleick, 1993).

Water plays a significant role in maintaining the human health and welfare. Clean drinking water is now recognized as a fundamental right of human beings. Around 780 million people do not have access to clean and safe water and around 2.5 billion people do not have proper sanitation. As a result, around 6–8 million people die each year due to water related diseases and disasters (Rahmanian N. et'al 2015). Therefore, water quality control is a top-priority policy agenda in many parts of the world. In the today world, the water use in household supplies is commonly defined as domestic water. This water is processed to be safely consumed as drinking water and other purposes. Water quality and suitability for use are determined by its taste, odor, colour, and concentration of organic and inorganic matters. Contaminants in the water can affect the water quality and consequently the human health.

However, this research work examined the quality of hand-dug well water samples which predominantly is the major source of water in Zing Local Government Area of Taraba state, Nigeria.

The research was specifically aimed at assessing the:-

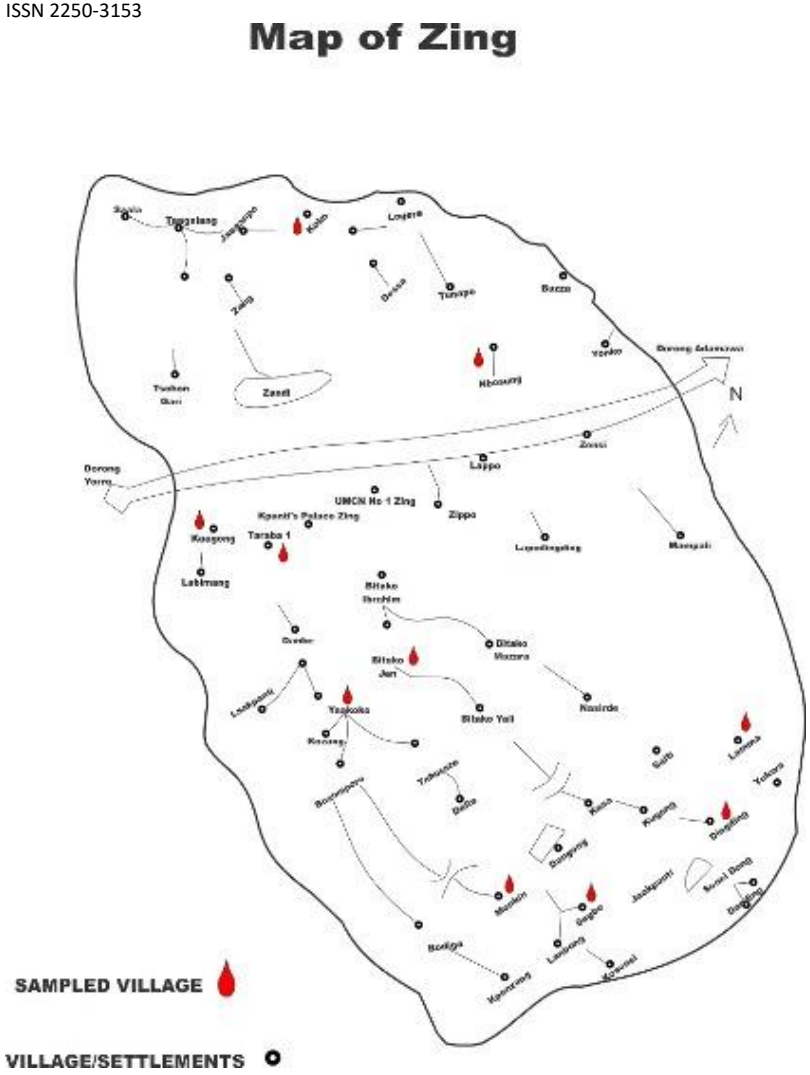
1. The physical parameters of (Temperature, PH, Total Dissolves Solid, Electrical Conductivity and Turbidity) hand dug well water samples in the ten political wards of the Zing Local government Area.
2. The concentration of inorganic (chemical) constituents of the hand dug well water samples in the local government area.

Materials and Methods

Study Area

Zing Local Government Area is one of the 16 LGAs in Taraba State, North-East Nigeria. It is bounded by Yorro LGA in the south, in the North-East and West respectively by Adamawa State. It has ten wards with Zing A_1 [zing town] as the headquarter. The area lies between longitude 10° and 11°E and latitude 9° and 10°N of the equator with land area of 1,030km^2 estimated population of about 170,600 (NPC 2016). The area falls within the transitional belt of savanna in north eastern Nigeria. It has good climatic conditions and rich in agricultural opportunities with the temperature ranging from 25 to 34°C, the mean annual rainfall of the area is 1,500 mm. The study area is endowed with abundant natural resources including, streams, natural grassland and economic trees. Musa Y.H et'al (2011). It is characterized by a tropical climate with two clear seasons; rainy seasons (May –October) and Dry seasons (November- April).

Fig. 1 sketch map of Zing showing the sampled community.



Sample Collection

Hand dug wells from the ten (10) political wards of the Zing Local Government Area were clearly located and identified. One (1) hand dug well per ward was purposively sampled considering the age of the well, the depth, the population of people using the well as the only source of drinking water and also the availability of the water in the well during the period under investigations. Ten (10) different samples were collected for the study on the 15th day of each month for a period of six months making a total of sixty

different samples were analyzed using standard methods. Clean sterile 1000ml plastic bottles labeled A_1, A_2, B, Yak., M_A, M_B, Lm, BTK, BU and Din. which represents Zing A_1 ward, Zing A_2 ward, Zing B ward, Yakoko ward, Monkin A ward, Monkin B ward, Lamma ward, Bitako Ward, Bubong ward and Dinding ward respectively were used for sample collection.

Analysis of physicochemical parameters of water samples:

The Physical characteristics were determined according to standard methods for the examination of water and wastewater, (APHA, 1998), these parameters includes PH, Electrical conductivity, temperature, turbidity and total dissolved solids (TDS) were determined in-situ using standard probe meter. TDS meter (3in1) were used to measure Total dissolves Solids, Electrical Conductivity and Temperature, Hanna PH meter were used to measure PH while turbidity were measured using turbidity meter Lutron TU-2016 model. Total Alkalinity and Total Hardness were determined titrimetrically in the laboratory. While chemical parameters such as chloride, sulphates, phosphates, fluoride, nitrates were analyzed at the Department of Pure and Applied Chemistry Laboratory, Adamawa state University Mubi using laMottewater analyzer and Buck 210VGP model-AAS for calcium and magnesium determinations.

Data Analysis. The data obtained from this study were analyzed using SPSS software version 20. The mean and standard deviation values were used to compare with the WHO (2006) and Nigerian Standard for Drinking Water Quality NSDWQ (2015) recommended/Permissible values for safe and drinking water quality.

Results and Discussions.

The mean and standard deviations of physicochemical parameters of the sampled hand dug wells in the ten (10) political wards of Zing Local government area were analyzed and presented as shown in Table 1.

Table 1. Mean and Standard Deviations of the Physicochemical Parameters of Hand Dug Well Water Samples in Ten Wards of Zing Local Government Area of Taraba State, Nigeria. (October 2019-march 2020)

	Wards												
Parameter	A1	A2	B	Yak.	M_A	M_B	Lm	BTK	Bu	Din	Mean:SD	Range	WHO	NSDWQ
Temp.	31.17	31	30.50	31	32	*30.50*	*30.17*	*30*	*29.8*	31.37	30.75±0.6765	29.83-32	ambient	ambient
PH	6.99	7.01	7.08	6.72	7.10	*7.40*	*6.58*	*7.54*	*7.79*	7.37	7.16±0.3703	6.58-7.79	6.5-8.5	6.5-8.5
EC .	820	358	663.67	905.67	217	*78.66*	*136*	*351.67*	*376.67*	323	423.03±281.53	78.66-905.67	1,000	1,000
Turb.	5.23	13.52	7.50	2.07	0.69	*34.59*	*53.74*	*7.83*	*12.58*	7.87	15.56±16.0871	2.07-53.74	5	5
T.A .	196.67	246.67	200	204.17	165	*118.33*	*87.50*	*170*	*224.17*	215	182.75±48.8668	87.50-246.67	-	150
T.H	239.67	202	286	337.67	99.17	*100.83*	*54.67*	*122*	*143.33*	141	172.60±90.9028	54.67-337.67	100-500	500
TDS	397.50	183.17	308.50	457	105.5	*93.83*	*65.0*	*180*	*190.50*	162.33	214.37±131.3902	65.0-457.00	500	500
Cl^-	1.53	0.53	0.83	0.60	0.67	*0.69*	*4.70*	*2.07*	*1.32*	0.34	1.33±1.2993	0.34-4.70	200-600	250
SO_4^{2-}	51.50	14	43	57.17	18.67	*14.0*	*35.67*	*13.3*	*13.05*	16	27.64±17.4720	13.05-57.17	200-400	100
PO_4^{2-}	5.87	12.42	1.65	1.86	10.69	*9.27*	*13.37*	*10.86*	*6.99*	11.83	8.48±4.2339	1.65-13.37	6.50	6.50
F^-	3.18	0.83	1.57	3.28	2.12	*1.00*	*2.38*	*5.18*	*6.50*	1.17	2.72±1.8737	0.83-6.50	0.5-1.5	1.50
Ca	12.56	1.82	14.49	16.23	3.17	*3.40*	*5.42*	*5.78*	*8.18*	4.43	7.55±5.1169	1.82-16.23	75-150	75
Mg	10.91	13.93	9.75	10.54	15.22	8.60	13.37.	8.22	15.77	9.31	11.56±2.7835	8.22-15.77	30-150	-
NO_3^-	16.85	9.28	8.82	3.12	9.90	9.82	34.78	4.75	5.08	5.82	10.82±9.2161	3.12-34.78	50	50

Source : Moses, A. N. and Ishaku, S. (2020).

All concentrations are expressed in mg/l except for the Temperature (ºC), turbidity (NTU), electrical conductivity (µs/cm), and PH has no units.

Temperature: The mean values for the hand dug wells water temperatures in the ten (10) wards of Zing local government area varies from 29.83ºC to 32ºC. The values obtained are within the recommended range of ambient temperature by National Standard for Drinking Water Quality (25ºC-33ºC) and WHO recommended values. Bubong ward (Bu) recorded the lowest mean value of 29.83ºC while Monkin A ward (M_A) recorded the highest temperature of 32ºC. The overall mean and standard deviations for the ten (10) sampled wells water temperature measured were 30.75±0.6765 for the period of October to march studied.

PH: defined by Sorenso as the $-\log[H^+]$. The test measured the acidity or alkalinity for the well water. The result indicated that the PH mean values for the ten (10) wards of Zing varies from 6.58-7.79 with Lamma (Lm) and Bubong (Bu) wards having the lower and upper limits respectively. The values are within the acceptable limits of 6.50-8.50 recommended by WHO (2006). The result showed the average value and standard deviations for the ten wards as 7.16±0.3703.

Electrical Conductivity (EC): This is the measure of the ability of the aqueous solutions to conducts electric current. The conductivity is dependent on the amount of soluble ions present in the solution, the mobility, valency of ions and the temperature of measurements. The observed mean and standard deviation value for the sampled hand dug wells in the ten wards were 423.03±281.53 which is within the permissible value recommended by WHO and NSDWQ. Lamma ward (Lm) has the lowest mean value of 136µs/cm while Yakoko ward has the highest mean value of 905.67us/cm.

Turbidity: Turbidity is an expression of the optical property that causes light to be scattered and absorbed. Turbidity in water is caused by suspended matter such as Clay, Silt, Finely divided organic and inorganic matter, Soluble coloured organic compounds, Plankton and other microscopic organisms. It is measured in Nephelometric turbidity units (NTU). This study revealed the mean turbidity value of 15.56±16.0871 for the sampled hand dug well water in the ten political wards of Zing. The value is far above the recommended and permissible value allowed by WHO and NSDWQ of 5 NTU. With the exception of Monkin A ward with turbidity value of 0.69NTU which is within the safe and recommended range by standard and regulatory bodies, all other wards Zing A1, Zing A2, Zing B, Yakoko, Monkin B, Dinding, Lamma, Bitako and Bubong wards recorded high value above the permissible value of 5 NTU see Table 1. The risk of having gastrointestinal diseases increases as the turbidity increases (Eri & Catherine 1997).

Total Alkalinity: This is the acid neutralizing capacity of the water due to all titratable bases in the water such as carbonates, bicarbonates, hydroxyl, phosphates, borates etc. 0.5N Sulphuric acid were titrated against 50ml of water sample using methyl orange / phenolphthalein as an indicator. The mean and standard deviation of all the sampled wells water were found to be 182.75±48.8668. The ranges of mean values for the Total alkalinity for the ten wards were from 87.50-246.67. Only Monkin B and Lamma has 118.33mg/l and 87.50mg/l respectively below the WHO recommended value of 150mg/l. while the Zing A1, Zing B, Zing A2, Yakoko, Bitako, Bubong and Monkin A were found to be higher than the maximum recommended value by the WHO and NSDWQ. See table 1.The high value may be due to carbonates, bicarbonates and hydroxyl ions present in the water.

Total Hardness: is defined as the sum of the calcium and magnesium concentrations, both expressed as calcium carbonates in mg/L. The mean and standard deviation for the ten wards studied were found to be 172.60±90.9028 with the ranged values of mean total hardness from 54.67-337.67. All the values are within the safe limits recommended by WHO and NSDWQ but are high enough to cause hardness of water except Lamma ward (54.67mg/l $CaCO_3$).

Total Dissolve Solids: is the portion of solids that passes through a filter of 2.0µm pores or smaller pore size. The mean and standard deviation values of total dissolve solids for the ten wards were 214.37±131.3902 with variation range from 65.00-457.00.mg/l. The obtained values were within the permissible value by WHO and NSDWQ with Yakoko ward having the highest mean value of total dissolve solids of 457.00mg/l while Lamma has the minimum or lowest mean value of dissolves solid of 65.00mg/l.

Chlorides Cl^- : Chlorides in water bodies are often as a result of dissolution of salt deposits, discharge of effluents and sewages, irrigation drainages, etc. it imparts a particular taste when present in high concentration above the WHO minimum and maximum permissible value of 200-600mg/l and 250mg/l for NSDWQ. The mean chloride ion concentration recorded for the ten (10) wards ranged from 0.34-4.70 with mean and standard deviation of 1.33±1.2993. This value is far below the permissible value recommended by WHO and NSDWQ.

Sulphates SO_4^{2-}: Occurs in natural waters and has laxative effects when in high concentration. Also causes corrosion and odour in waste water treatment due to reduction to hydrogen sulphide (H_2S). The mean value obtained for each of the wards studied were low compared to WHO and NSDWQ permissible values of 400mg/l and 100mg/l respectively.

Phosphates PO_4^{2-}: Phosphate occurs in traces in many natural waters, and often in appreciable amounts during periods of low biologic productivity. Waters receiving raw or treated sewage, agricultural drainage and certain industrial waters normally contain significant concentrations of phosphate. The phosphates concentrations obtained in all the wards were above the limits of 6.50mg/l and 0.3mg/l recommended by WHO and NSDWQ respectively except Zing A1, Zing B and Yakoko wards this is in line with what was reported by Sulaiman et al 2015. This may be due to rocky nature of Zing Local government area and likely presence of high phosphates bearings rocks in ground water aquifers.

Fluorides F^- : This is one of essential parameters in water to monitor due to its effects when in high or low concentrations. The mean and standard deviations for all of the ten wards (Table 1.) Were 2.72±1.8737 which is higher than the acceptable concentrations permitted by WHO and NSDWQ. Only Zing A2, Monkin B and Dinding ward has the mean concentration within the permissible limits while Bubong ward has the highest mean value of 6.50mg/l followed by Bitako, Yakoko, ZingA1, Lamma, Monkin A and Zing B in decreasing order. This result showed the likely reason for the cases of mottles teeth commonly found in in Zing are from the water sources.

Calcium Ca: The mean values for the ten (10) wards in Zing were obtained to be 7.55 with standard deviation of 5.1169. The concentration in mg/l ranges from 1.82-16.23 with Zing A2 having the least mean value while Yakoko had the maximum concentration of 16.23mg/l. The result indicated that all the concentrations in the ten (10) wards were below the minimum permissible value by WHO and NSDWQ.

Magnesium Mg: The concentraton of magnesium in the studied wards ranges from 8.22-15.77 with the mean value of 11.56 and standard deviations of 2.7835. These values were far below the permissible value for the magnesium concentration in safe water for drinking as recommended by WHO and NSDWQ.

Nitrates NO_3^- : High Nitrates ions concentration in water meant for drinking causes blue blue diseases in infants and promotes algal growth. The sources of this ions into water bodies includes decayed vegetables, fertilizers and manure, leachates from dump refuse, industrial discharge etc. The result showed that the mean concentration for the ten wards in Zing were 10.82 with standard deviation of 9.2161. This value is below the permissible value recommended by the WHO and NSDWQ. See Table 1.

Conclusions:

The main aim of the research was to assessed the physicochemical properties of the hand dug well water samples in the ten (10) political wards of Zing Local Government Area of Taraba state. The study revealed that the well water had an ambient temperature ranges from 25ºC to 32ºC in all the ten wards. The PH and electrical conductivity were within the safe limits. The chemical parameters of chlorides, sulphates, calcium, magnesium and nitrates were found to be within the WHO and NSDWQ permissible values whereas turbidity, total alakalinity, fluoride and phosphates were found to exit the maximum value permitted. It is therefore concluded that for drinking and other domestic utilizations of these well water by the community, proper treatment should be done to avoid being exposed to health effects posed by parameters that are above the permissible limits.

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