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Physical and Chemical Parameters in Well-Water of Selected Location within North Bank, Makurdi, Benue State

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Abstract
Six different samples of well waters were collected within North Bank, Makurdi. The samples collected were tested for both physicochemical parameters and heavy metal analysis in the laboratory. The physicochemical parameters include colour, taste, odour, pH, acidity, alkalinity, hardness, calcium and magnesium, while the heavy metals are as follows: manganese, nickel, lead, chromium, iron, Cadmium and zinc. Heavy metal analysis was carried out using Atomic Absorption spectroscopic (Model AA6800 Shimadzu-Automated). From the results of the analysis, temperature ranges from 28.02 to 29.66^{o}C, $_{p}$H 5.9 to 6.92mg/L, acidity ranges from 34.7 to 48.7 mg/L, total alkalinity ranges from 41.8 to 19.01 mg/L, total hardness ranges from 112 to 155 mg/L, calcium ranges from 29.62 to 61.14 mg/L, magnesium hardness ranges from 60.2 to 74.2L, however the mean concentration of the heavy metal are as follows (Mn 0.25; Ni 0.023; Fe 0.46; Pb 0.09; Cr 0.03; Cd-0.30; Cu 1.67; Zn 1.79). The results of the analysis generally revealed that all the samples fall within the acceptable standard for drinking water by World Health Organization (WHO) and Standard Organization of Nigeria
Keywords: Physical and Chemical parameters, heavy metal, Well-water, North Bank, WHO.

Introduction

Water is an essential resource and it exists almost everywhere under most landscapes. It is one of the sources of fresh water and constitutes about 0.3% of usable water, though of small amount, well water is the source of safe water supply for many parts of the world [1].Water should be clear, colorless, tasteless, odorless, and devoid of suspended matter or turbidity [3]. In Africa, many cities, towns and villages depend almost entirely on it for their domestic, agricultural and industrial needs. Globally, 1.1 billion people do not have access to adequate and potable water supply and over 460 million people are currently suffering acute water shortage, and 2.4 billion lacking adequate sanitary facilities. Increasing demand, coupled with limited supply (pipe born water) has forced urban dwellers to resort in use of well water for drinking, bathing and other domestic uses [4]. The hand-dung wells are in most cases cited in unsanitary locations (close to refuse dumps, pit latrines or suck-away systems). Some of the wells are even left open and are therefore prone to contamination of various types and degrees [5].

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, and are introduced 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, processing and the use of metal-based materials [6]. The increased use of metal-based fertilizer in agricultural revolution of the government could result in continued rise in concentration of metal pollutions in fresh water reservoir due to the water run-off. Also, faucal pollution of drinking water causes water born disease which has led to the death of millions of people [9].

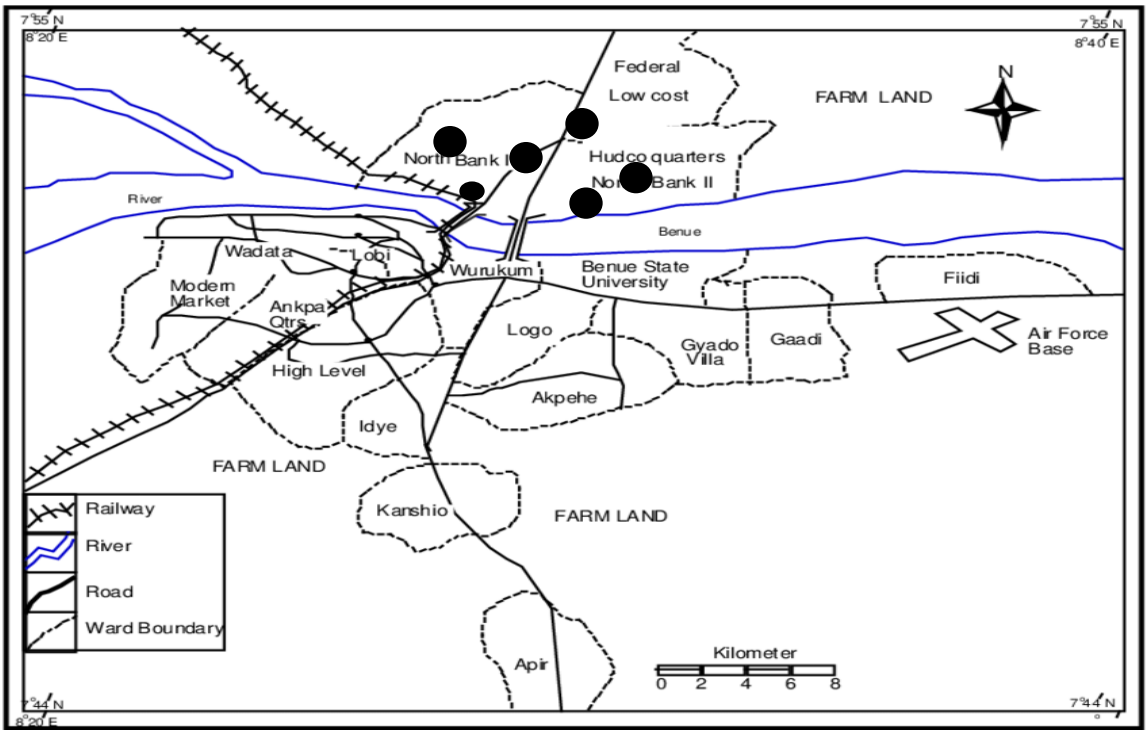
The quality of groundwater is generally stable over time as it is predominantly determined by the chemical composition of the rocks serving as aquifer [12]. However, hand-dug wells, which are the focus of the present study, are sometimes situated near sewage and septic tanks, hence, the need for biological test to examine how poor sanitation practice and other human activities impact on them. From the foregoing, water quality poses a challenge worth investigating. It is on this premises that the present study set for itself the task of assessing the quality of well water in north Bank metropolis to determine its suitability for consumption vis-à-vis to determine the quality of well water using acceptable standard set by Standard Organization of Nigeria (SON) and World Health Organization (WHO) for domestic water use and consumption. The results of the study would be found useful in the determination of the various uses to which well water in the study area can be put to in accordance with acceptable standard.

Materials and Methods

Study Area

North bank is located north west of Makurdi Metropolise Benue state, Nigeria. A total of six samples were collected from six different locations within North Bank area of Makurdi. The samples are labelled as follows

S/N	Sample	Area	Name of Place
1	S1	Angwa Kabawa	North Bank
2	S2	Angwa Gengeri	North Bank
3	S3	SRS Junction	North Bank
4	S4	AngwaGerinpe	North Bank
5	S5	Ajio Steel	North Bank
6	S6	B/Hudco QTD	North Bank



The Map: showing sample location.

Keys: indicate the sample location

Sample collection

Sampling bottles were used for sample collections. Prior to sampling, bottles were rinsed twice with distilled water. Neck of bottles was tightly sealed. On getting to the sampling points the bottles were further rinsed severally with the water to be collected, sampling bottle were partially filled with the collected well water and vigorously shaken to note the odour.

Determination of Physical and Chemical Properties

The analysis of various Physico-chemical parameters analyzed pH, odour, colour, temperature, electrical conductivity, turbidity, total hardness, nitrate, chloride, dissolve oxygen, biological oxygen demand(BOD), chemical oxygen demand, were carried out as per method described in [2, 6]

Determination of Heavy Metals in Well Water Samples

The well water samples were digested as follows; the samples (100mL) were transferred into a beaker and 5mL concentrated HNO_3 was added. The beaker with the content was placed on a hot plate and evaporated down to about 20mL. The beakers were cooled and another 5mL of concentrated HNO_3 was added. The beakers were covered with watch glass and returned to the hot plate. The heating continued, and then small portion of HNO_3 was added until the solutions appear light coloured or becomes clear. The beaker wall and watch glass were washed with distilled water and the samples were filtered to remove some insoluble materials that could clog the atomizer. The volume of the samples was adjusted to 100cm^3 with distilled water [14]. The digested samples

Were then analyzed for heavy metals using Atomic Absorption Spectrophotometer (model AA6800 Shimadzu-Automated).

Results and Discussion

Table 1.0: shows the physico-chemical parameters of well water

Physico-chemical parameters	NBAK	ANGG	SRSJ	NBAG	NBAS	BNAQ
pH	6.5	6.35	6.43	5.9	6.7	6.92
Temp (°C)	28.02	28.08	29.1	29.66	29.04	28.08
EC (µS/cm)	80.7	93.9	101.2	74	90.3	92.6
Total Hardness(mg/L)	132.58	148.35	127.14	112.68	155.41	127.03
Total Solid (mg/L)	56.2	67.4	92.33	62.3	77.6	81.6
Total Dissolve Solid (mg/L)	113.94	126.18	88.46	101.94	97.81	94.79
Total Soluble Solid (mg/L)	142	199.5	203.8	143.45	154.65	163.25
Total Alkalinity (mg/L)	14.81	18.99	26.54	16.67	24.32	19.01
Total Acidity (mg/L)	45.4	32.35	48.7	39.73	47.5	34.7
PO_4^{3-} (mg/L)	0.08	0.09	0.06	0.05	0.07	0.07
NO_3^{2-} (mg/L)	3.29	4.25	3.17	5.38	4.66	4.71
Dissolve Oxygen (mg/L)	4.12	4.19	5.06	5.23	4.73	4.66
Biological Oxygen Demand(mg/L)	3.96	4.01	4.83	4.94	4.14	4.03
Total Chloride (mg/L)	30.19	25.12	24.18	39.17	37.9	48.04
Calcium (mg/L)	61.14	48.36	53.12	48.49	34.54	29.62
Magnesium (mg/L)	65.2	69.3	70.1	75.2	60.2	74.2

Table 2.0: shows the concentration of heavy metals

Heavy metal	NBAK	ANGG	SRSJ	NBAG	NBAS	BNAQ
Mn	0.2401	0.2529	0.2131	0.2834	0.3167	0.2239
NI	0.028	0.0201	0.0302	0.0187	0.0195	0.0237
Fe	0.3048	0.2884	0.567	0.68	0.354	0.6089
Pb	0.0101	0.235	0.0149	0.0265	0.1432	0.1137
Cr	0.0296	0.0401	0.0377	0.043	0.046	0.013
Cd	0.4001	0.1804	0.2307	0.3644	0.2128	0.4555
Cu	1.42	1.995	2.0380	1.4345	1.5465	1.6325
Zn	1.8102	1.9901	2.0412	1.6709	2.1205	1.156

Table 3.0: Water Standards and Analysis

S/N	Parameters	Standards			Descriptive Statistics		
		WHO	SON	N	Range	Minimum	Maximum
1	Temperature (oC)	29	Ambient	6	1.02	28.02	29.04
2	pH	6.5 - 8.5	6.5 - 8.5	6	1.02	5.9	6.92
3	TDS (mg/L)	500	500	6	37.72	88.46	126.18
4	Nitrate ion (mg/L)	50	50	6	2.21	3.17	5.38
5	Sulphate ion (mg/L)	200	100	6	0.04	0.05	0.09
6	Chloride ion (mg/L)	400	250	6	23.86	24.18	48.04
7	Magnesium ion (mg/L)	50	20	6	15.0	60.2	75.2
8	Calcium (mg/L)	75	75	6	31.52	29.62	61.14
9	Alkalinity (mg/L)	120	100	6	6.55	18.99	26.54

Discussion

The result shows that the mean temperature for well water is 28.7◦C. The temperatures of the well water collected in all the sample locations respectively fall within acceptable standard limits. The Total Dissolved Solid (TDS) was found to be lower than that determined for well waters in Kubwa, FCT [12, 6].The mean conductivity was found to be 88.87µs/cm. NBAG had the least value of 74µs/cm while ANGG has the highest of 148µs/cm. These values were also lower than that determined value of well waters in Kubwa[6] which had conductivities values of 155µs/cm though higher than determinations made for bore holes in Gusau [13,10]. This expresses the level of dissolved ions in the well waters.The pH expresses the extent of acidity or alkalinity of a sample. It was found to have a mean value of 6.4. This is an indication of weak acidity. The well water types may be such that it permits dissolution of materials which bring about slight acidity in the sample. The pH was found to be lower than that for Kubwa though slightly higher than that for Gusau well waters. It however falls within the accepted range of 6.5-8.5.Nitrate was determined to be 4.24 mg/L. The presence of nitrates in a water sample could be due to inorganic fertilizers, plants and animal decomposition and wastes which may have percolated the waters over time [11]. The mean value for well water in Gusau (3.09 mg/L) was higher than that for the nitrate level for Wukari and even much lower for well waters in Akure which range between 30-61 mg/L [12].Phosphate and chloride mean level were found to be 0.07 mg/L and 34.1 mg/L, respectively. The presence of phosphate in a water source could be attributed to discharges from detergents, animal wastes and related contaminants. The presence of chlorides on the other hand in natural water could be attributed to pollutions from sewage, minerals and industrial effluents [8].The mean value for alkalinity was found to be 20.05 mg/L. This expresses the component of the water sample.Water hardness values for the well water sample is 140 mg/L though the NBAS values of 155mg/L indicated were above the permissible levels and BNAQ, NBAG, and NBAK had values that were lower than the accepted limit of 150 mg/L. The reason for this variation is not clear but may be due to variations in the geochemical features of the soil in moving from one part of the location to the other. It may also be an indication of the presence of limestone, gypsum, dolomite or other calcium or magnesium containing minerals in the soil. The well water samples may therefore be described as hard thus creating difficulty for washing generally because it would not form lather with soap easily. It would however be good for drinking because hard water may be preferable to soft water for the purpose of drinking. BOD and DO shows a mean value of 4.03 mg/L and 4.6 mg/L respectively. These parameters are important for the sustenance of aquatic lives. BOD test has been indicated to represent the amount of dissolved oxygen consumed by bacteria growing in organic material in water sample; Lead (Pb) concentration was detected in all the samples. Lead concentration ranged from 0.002±0.001 to 0.014±0.001 mgL^{-1}. Highest concentration of 0.026mgL^{-1} was in NBAG. The lead detected in all sample were found to be below WHO permissible limits for lead in drinking water of 0.01mgL^{-1}[5].The findings suggested that the samples analysed are safe and are within the recommended permissible limit of 0.015 mgL^{-1} recommended by both SON and WHO[5].

The concentration of cadmium in the water samples ranges from 0.1804 - 0.455 mgL^{-1}. The cadmium detected in all sample were below WHO permissible limits for cadmium in drinking water of 0.01mgL^{-1}[5].

Zinc was detected in all samples; the highest concentration of 2.12mgL^{-1} was detected in sample NBAS and the lowest concentration of 1.15mgL^{-1} were detected in BNAQ. All the water samples containing zinc are below the WHO maximum permissible limit of 5.00mgL^{-1}[5]. Nickel was also detected in all the samples. The highest concentration of 0.0302mgL^{-1} was detected in sample SRSJ and the lowest was detected in NBAG 0.0187mgL^{-1} Most of the results obtained were found to be within the WHO

Maximum permissible limit of 6mg/L^{-1}[3,5]. Chromium was detected in all the samples. The detected sample has the highest concentrations of 0.0401mgL–1 in ANGG. Chromium concentration are below the WHO maximum permissible limits of 0.500mgL^{-1}. WHO and SON recommended a maximum of 0.5 mgL^{-1} for chromium in drinking/potable water, thus the water analyzed is safe for consumption.

Highest concentration of copper was 2.038mgL^{-1}in ANGG while the lowest concentration was 0.013mgl – 1 at BNAQ. All the water samples analyzed for copper were found to be within WHO permissible limits of 5.0mgL^{-1}[3,5].

Manganese was detected in all the water samples. The highest concentration of 0.316mgL^{-1} was detected in NBAS and the lowest concentration of 0.213mgL^{-1} was detected in SRSJ. Magnesium in trace quantity is considered an essential element,this value is lower than WHO and SON recommended values of 0.5 mg/L and 0.05 mg/L respectively (WHO, 2011 and SON, 2011).How ever Iron concentration was also found in all the water samples, but the highest concentrations of 0.68.3mgL–I was detected in NBAG and the lowest concentration of 0.288mgL–I was detected in ANGG sample, All samples analyzed were below WHO permissible limits for iron in drinking water of 0.02mgL^{-1} (WHO2011).

Conclusion

From the results discussed above, it is clear to see that Water samples taken from wells within north bank are relatively safe for consumption. The pH values suggested that the water samples are slightly basic in nature as none was found to be acidic. The low values for electrical conductivity (EC), also meant that water has low concentrations of cations and anions. It could be concluded that the water samples are fit for consumption as well as good for agricultural and other application.

References

[1] Isah, A. M., Salau, O. B. E., Harir I. A., Chiroma, M. A. and Umar, A. A. (2015). **An Assessment of Water Quality from Hand Dug Wells in Hardo Ward Bauchi Metropolis; Nigeria**. 1st International Conference on Innovation in Science and Technology. Proceedings 20th April 2015, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia

[2] Aremu, M. O., Olaofe, O., Ikokoh, P.P. and Yakubu, M.M. (2011). **Physico chemical characteristics of stream, well and borehole water sources in Eggon, Nasarawa state, Nigeria.** *Journal of chemical society of Nigeria,* 36(1): 131-136

[3] Standard Organization of Nigeria. (2007). **Nigerian Standard for Drinking Water Quality** Pp 29.

[4] Sa'id, M.D. and Imoh, W.L.O. (2012) **Trace metals concentration in drinking water supplies from some selected areas of Kano metropolis and it's environment, Kano state, Nigeria**. *Biological andEnvironmental Science Journal for theTropics, 9(3):*212-214.

[5] WHO (2011). **World Health Organization Guidelines for Drinking Water Quality**, 4th Edition Pp 34 – 38. Geneva, Switzerland Pp

[6] Adefemi, S. O. and wokunmi, E. E. (2010), **Determination of physico-chemical parameters and heavy metals in water samples from Itaogbolu area of Ondo-State**, *Nigeria, African Journal of Environmental Science and Technology*, 4(3) :145-148.

[7] Jidauna, G. G., Dabi, D. D., Saidu, J. B., Abaje B., and Ndabula C. (2013). **Assessment of well water quality in selected location in Jos, Plateau State, Nigeria**. *Intational. Journal Natural. Atmospheric Earth Science.* 1(1): 38-46.

[8] Ujoh, F. and Muhammad, M. (2011). **An Assessment of Ground Water Quality for Drinking from Hand-Dug Wells in Masaka, Nigeria**. Bayero University *Journal of Social and Management Studies.* 14(1): 79-95.

[9] Agbede, I. O. and Akpen, G. D. 2008. **Bacteriological and Physio-Chemical Qualities of Groundwater in Makurdi Metropolis**: *Global Journal of Environmental Science*. 7 (1 and 2): 29-34.

[10] Ajayi, O.O., Ogun, J. and Oguntimehin, I. I. (2002). **The Influence of Waste Dumps on Some Underground Water Sources in Warri**. *Journal of Science Laboratory Technology International.* 1(1): 34-39

[11] Gideon, R. K. (1999). **An Assessment of Current Level of Pollution of Hand-dug wells in Samaru Zaria: MSc Geography Unpublished Dissertation,** Department of Geography Ahmadu Bello University Zaria, Nigeria. Pp 25-30

[12] Babu, N. V., Rao P. J. and Prasad, I. V. (2013). **Impact of Municipal Solid Waste on Groundwater inthe Environs of Greater Visakhapatnam Municipal Corporation Area, Andhrapradesh,** India. *International Journal of Engineering Science Invention*. 2(3).

[13] Abimbola, A. F., Ajibade, O. M., Odewande, A. A., Okunola, W. O., Laniyan, T. A. and Kolawole, T. (2008). **Hydrochemical characterization of water resources around the semi-urban area of Ijebu-Igbo**. *International research Journal of environmental sciences.*1 (2): 23-29

[14] Kumar, M., and Kumar, R. (2013). **Assessment of physic-chemical properties of groundwaterin granite mining areas in Goramachian, Jhansiup, India.** *International research Journal of environmental sciences.*2 (1): 19-24.

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