REQUIRED WATER QUALITY STANDARD VIS-À-VIS THE ANALYSIS OF PHYSICO-CHEMICAL AND HEAVY METALS CRITERION IN THE TOWN OF OZORO

Akwenuke, O. Moses
P.O.Box 2139 Warri
mosessireh@ymail.com/mosesyisireh@gmail.com

ABSTRACTS
Water quality standard which indicate the levels that will not cause hazard in its use was investigated in selected parts of Ozoro Town but with respect to purpose for its chemical, physical and heavy metals. Some suspected location in Ozoro were investigated for safe drinking water quality to ensure that the borehole drinking water which is common amongst the residents is clean and safe. Thus, a detailed physico-chemical analysis of drinking water was carried out by using samples from 10 locations of Uruto, Erovie, Etevie, Urude, Oruamudhu, Alaka, Etereva, Emese, Esekpe and Oda. Parameters such as pH, electrical conductivity (EC), Turbidity, Total dissolved solid (TDS), Total suspended solids (TSS), Taste and odour including minerals and heavy metals such as cu, nitrate ($N0_3$), nitrite ($N0_2$), Fe, Pb, As, cd, Zn, Mg and $C0_3$ were analyzed for each of the water samples collected from the taps in each of the locations. The outcome results and values of each of the parameters obtained were then compared with the standard limit values of World Health Organization (WHO) and that of Nigerian Safe Drinking Water Quality (NSDWQ) standards and were found to be safe as drinking water because the values of each of the parameters are within the safe limits set by WHO and NSDWQ.

Keywords: *Analysis, taste, solids, Ph value of water, wholesome water, concentration of H^+ ions, acidity, alkalinity, colour, total solid.*

INTRODUCTION

In a water cycle system diagram, water travels to the atmosphere through evaporation from surface waters such as oceans and rivers and then travels back to the earth surface through rainfall (rain water) (Narasimhan, 2009). Rain water is originally pure but while falling down through the atmosphere, it absorbs oxygen, carbondioxide, dust and other gases present in the atmosphere. And when the water touches the ground and flows over and through the ground surface it then become available as a water resource in underground, lakes, oceans, streams and rivers (Inglezakis & Menegala, 2016). So as it flows, the water then captures inorganic substances from the soil, organic substances and microorganisms which are generated through the activities of humans and

due to the nature occurrences of the ecosystems (Scatena, 2000). Both surface and ground water collect some harmful organisms which are injurious to health of human beings (Miller, 1999).

Hence, the idea of a water quality standards, is the extent to which it shows the levels that will never cause any form of hazard in accordance to the purpose of water usage or to the human body.

Therefore the scientific analysis and examination of the safety of water for each purpose of its use is highly required in order to establish water quality standards through analysis for types of impurities present in the water and its properties through examination for physical, chemical and bacteriological characteristics (Heckel&Dombek, 2009).

According to Un-water, coordinated by UNESCO in collaboration with UENCE and UNDESA (2013) and reported by N. Rahmaman (2015), water plays a significant role in maintaining the human health and thus is not debateable: up to about 780 million people do not have access to clean and safe water and around 2.5 billion people do not have proper sanitation, therefore as a result about 6 – 8 million people die each year due to water related diseases and disaster,

Therefore, to ascertain various types of impurities present in water, analysis of water is not only a top priority but also highly advised (Miller, 1999). The outline for water treatment is as a result of water analysis and by it, types of impurities and the extent they are present are known (Buskell, 2003). It is also about what units of treatment to be carried out to purify the water so that the water will be safe and pure for consumers.

The measure of the suitability of water meant for a particular use which is based on physical, chemical and biological characteristics explains water quality (WHO, 2011).

The importance of water quality is seen in a healthy ecosystem (Dissmeyer, 2000). Quality clean water supports variety of plants and wild life. Temperature, pH, dissolved oxygen, turbidity, specific conductance, hardness and suspended sediment are water properties which are important in determining water quality (Elango, 2000).

Water available in nature from different sources is never pure and absolutely fit for domestic, industrial and agricultural use (Nollet, 2000). This is because it contains a number of impurities in varying amounts.

Taste, odour, colour including the concentration of organic and inorganic matters are the determinant of quality of water and its suitability for use (Dissmeyer, 2000). Water quality can be affected by contaminants in the water and hence human health as well. Agricultural and industrial activities including geological conditions are the major potential water contamination sources and which are further classified as radionuclides, organics, inorganics, disinfectants and microorganisms (L. Nollet, 2000). Comparing inorganic chemicals to organic chemicals, the inorganic chemicals has a greater percent portion of contaminants in drinking water (A. Azrina, 2011). Part of inorganics can be said to be in mineral form of heavy metals which are known to be source of health problems in humans. Series of scientific tools and procedures have been developed in order to access the water contaminants burden (Dissmeyer, 2000) and these procedures involves the tests and analysis of individual criterion as in pH, Total Suspended Solid (TSS), Electrical Conductivity (EC), turbidity, Total Dissolved Solid (TDS) and heavy metals such as copper (cu), iron (fe), lead (pb), Asene (As), cadium (cd), zinc (zn) and magnesium (mg). These mentioned parameters can affect the quality of drinking water when their values are in higher concentration than WHO and NSDWQ set safe limits (WHO, 2011) and hence the regular investigation of drinking water quality is compulsory and necessary.

In Ozoro town, the main source of water is underground and like surface water, depends on rainfall as well. Ozoro is one of the fast developing towns in not just Isoko nation but in Delta State as a result of its been the headquarter of the Isoko North Local Government including in flow of businessmen and women settling there, the presence of a state owned higher institution such as the now University of Science and Technology (formerly Delta State Polytechnic) and housing offices for all the state ministries and for these reasons, population is geometrically increasing and as well as infrastructural development, therefore the eventual consequent effects of inadequate water availability hence the need for private development of borehole wells by residents. There is basically no official information available concerning drinking water quality and available sources of water contamination, thus it becomes critically crucial to explore and evaluate the drinking water quality standard of Ozoro urban township in order to be confident of safe drinking water for the residents of Ozoro urban residents and even transiting non-residents. Therefore, this study is aimed at assessing and gauging required drinking water quality standard vis-à-vis the analysis of its physic-chemical and heavy metals parameters through the investigation of borehole well tap water samples from 10 locations of Ozoro urban town and then comparing the determined values with that of recommended drinking water quality standards of World Health Organization (WHO) and Nigeria Safe Drinking Water Quality (NSDWQ) guidelines.

MATERIAL AND METHODS

Study Area

Sampling and laboratory analysis is the method adopted for this study. A sampling field exercise were done and the analysis of the samples were done at the Delta State Urban Water Corporation (DSUWC), Asaba. The research work is restricted to ten selected communities in Ozoro urban town namely; Uruto, Erovie, Etevie, Urude, Uruamudu, Alaka, Etereva, Emese, Esekpe and Oda.

The study area is Ozoro township. Ozoro is the headquarters of Isoko North Local Government Area of Delta State, South-South Nigeria and hence the administrative hub and capital city of the Isoko North people of Isoko Nation. Ozoro has a population of approximately 187,000 inhabitants (2006 national population census). It is the most commercial and most populated town in Isoko land. Ozoro lies between longitude $6^0 12^1 58^{11}$ E and latitudes 5^0 2^1 18^{11} N. Ozoro has a water works treatment plant and is one of the regional zonal office of the Delta State Urban Water Corporation. The raw water supply is underground water. The plant distributes the treated water to Ellu and Oleh apart from Ozoro township. Because of population increase and increase in infrastructural development, the plant supply is inadequate hence most people resort to drilling of boreholes. These borehole wells are the water source of this study.

Selection of Sampling Location

The parameter of selecting sampling points were based on the areas were new developments are taking place and very densely populated areas. The purpose is to establish the water quality of these areas and compare them to acceptable known water quality standards (table 2), hence for subsequent decision to treat or not to treat. 10 different locations were chosen which comprises of one each from ten communities of Uruto, Erovie, Etevie, Urude, Uruamudu, Alaka, Etereva, Emese, Esekpe and Oda.

Sample Collection

Drinking water samples were collected from borehole tap water of residential and commercial areas. Bottled water imported to Ozoro were not part of sample taken, also,

sample were not collected from the state own water corporation taps, this is so because the study aim is to establish the water quality of Ozoro town whose source is untreated. The samples were number from 1 to 10 against their location and sources (Table 1) in 1 litre polyethylene plastic bottles after being made clean with deionized water before use. Numbers were given to each of the samples from 1 to 10 against their location and source (Table 1). 1 litre polyethelene bottles were used to collect the samples after been washed with deionized water sealed and kept in a dark environment of a constant temperature ranging from 4^0c to 10^0c to keep the samples away from effects of high temperature and to avoid contaminating any of them pending when they will be taken to the laboratory if it is not possible same day. The water samples collected were handed over to the Delta State Water Corporation headquarters' laboratory for analysis and test through its zonal Ozoro office manager which is accredited for majority of chemical tests commonly required for water quality analysis and assessments.

Table 1: Drinking water sample Numbers, location and source

Identity Number	LOCATION	SOURCE
1.	URUTO	Tap water from private home borehole.
2.	EROVIE	Tap water from private home borehole.
3.	ETEVIE	Tap water from private home borehole.
4.	URUDE	Tap water from private home borehole.
5.	URUAMUDHU	Tap water from private home borehole.
6.	ALAKA	Tap water from private home borehole.
7.	ETEREVA	Tap water from private home borehole.
8.	EMESE	Tap water from private home borehole.
9.	ESEKPE	Tap water from private home borehole.
10.	ODA	Tap water from private home borehole.

Laboratory Analysis

All the samples indicating their location and source were submitted to the Delta State Urban Water Corporation Laboratory for test and analysis through its Ozoro zonal office. To be tested and analysed are the pH of the sample including conductivity, turbidity, TSS, TDS, metals amongst others as indicated in table 3 and 4.

Table 2: Permissible Safe Limits of WHO and NSDWQ for Determining Drinking Water Quality Standard

	Parameters	World Health Organization (WHO) Limits	Nigeria Safe Drinking Water Quality (NSDWQ) Limits
(A)	**Physico-Chemical**		
1.	pH	6.5 – 8.5	6.5 – 8.5
2.	Conductivity *(µs/cm)*	300	1000
3.	TSS *(mg/l)*	500	500
4.	TDS *(mg/l)*	1000	500
5.	Turbidity (NTU)	5	5
B.	**Mineral and Heavy Metals**		
6.	Copper *(mg/l)*	2	1
7.	Zinc *(mg/l)*	5	3
8.	Magnesium *(mg/l)*	-	0.2
9.	Iron *(mg/l)*	0.3	0.3
10.	Cadium *(mg/l)*	0.003	0.003
11.	Lead *(mg/l)*	0.01	0.01
12.	Chloride *(mg/l)*		250
13.	Nitrate *(mg/l)*		50
14.	Sulphate *(mg/l)*		100
15.	Bicarbonate *(mg/l)*		-
16.	Calcium *(mg/l)*		75
17.	Dissolved oxygen *(mg/l)*		5.0
18.	Arsenic		0.01
19.	Hardness ($caco_3$)		150
20.	Manganese		0.2

Table 3: Physico-chemical condition of drinking water in Ozoro town Isoko North, Delta State, Nigeria

Samples	Location	pH	Electrical conductivity (EC*µs/cm)*	Turbidity (NTU)	Total Dissolved Solid (TDS *mg/l)*	Total Suspended Solids (TSS *(mg/l)*	Taste	Odour
1.	URUTO	6.6	96.4	0.18	30	4.4	No off Taste	No off odour
2.	EROVIE	6.7	78.2	0.67	25	3.2	No off Taste	No off odour
3.	ETEVIE	6.8	85.3	1.3	29	3.8	No off Taste	No off odour
4.	URUDE	6.6	97.8	0.89	28	3.5	No off Taste	No off odour
5.	URUAMUDHU	6.9	87.1	3.4	34	4.65	No off Taste	No off odour
6.	ALAKA	6.9	91.2	3.2	37	1.9	No off Taste	No off odour
7.	ETEREVA	6.6	84.4	0.74	22	0.0	No off Taste	No off odour
8.	EMESE	6.9	79.8	3.5	20	2.2	No off Taste	No off odour
9.	ESEKPE	6.5	70.8	0.25	38	0.0	No off Taste	No off odour
10.	ODA	6.8	91.5	1.65	37	1.8	No off Taste	No off odour

Table 4: Concentration of mineral and heavy metals (*mg/l*) in drinking water samples of Ozoro town, Delta State, Nigeria

Sample	Location	□□ *mg/l*	$N0_3$ *mg/l*	$N0_2$ *mg/l*	Fe *mg/l*	Pb *mg/l*	As *mg/l*	Cd	Zn	Mg	$C0_3$
1.	URUTO	0.03	1.21	0.02	0.07	0.001	0.004	.0001	0.006	0.188	2.05
2.	EROVIE	0.00	3.8	0.04	0.08	0.001	0.0006	.004	0.007	0.188	1.03
3.	ETEVIE	0.05	1.09	0.08	0.05	0.01	0.0006	.0006	0.004	0.194	2.15
4.	URUDE	0.04	0.15	0.05	0.032	0.00025	0.0005	.0005	0.003	0.20	0.95
5.	URUAMUDHU	0.02	2.8	0.01	0.021	0.0012	0.0002	.0006	0.001	0.224	0.35
6.	ALAKA	0.05	1.25	0.06	0.04	0.0024	0.0008	.0006	0.005	0.202	2.07
7.	ETEREVA	0.06	40.40	0.03	0.06	0.0002	0.0003	.0005	0.002	0.20	1.05
8.	EMESE	0.04	5.65	0.07	0.03	0.0003	0.0004	.0006	0.004	0.201	0.09
9.	ESEKPE	0.05	30.42	0.02	0.09	0.02	0.0001	.00007	0.008	0.209	0.38
10.	ODA	0.06	6.55	0.02	0.01	0.002	0.0007	.0005	0.001	0.204	1.05

RESULTS AND DISCUSSION

Result

The outcome of the laboratory test is as shown in table 3. pH value is one of the most key prime water criterion and its measurement relate to acidity or alkalinity of the water in which it is acidic if pH is less than 7.0 and alkaline of the pH value is greater than 7.0. Corrosion of metal pipes is as result of acidic water. WHO

pH value recommendation is between 6.5 and 8.5 for normal drinking water. The pH value of all the samples are found to be within the WHO recommended maximum value of 8.5 and above 6.5. The highest pH value was from sample at Emese, Alaka and Uruamudhu having a value of 6.9 while the lowest is 6.5 from sample taken from Esekpe. This means all the sample should be accepted since they met WHO and NSDWQ recommendation of between 6.5 and 8.5. The result also confirmed that Ozoro underground water is not alkaline since none of the result is greater than 7 and this is an evidence of genuineness of the results as underground water is not alkaline except otherwise.

Discussion

Electrical Conductivity: The ability of a medium such as water to carry an electric current defines electrical conductivity and it is the presence of calcium, chloride and magnesium in water samples that takes electric current through the medium (water). According to NSDWQ limit (table 2), allowable limit level of measured electrical conductivity of all samples of the water ranges from lowest of 70.8 (Esekpe) to highest of 97.8 (Urude) (Table 3) with an average electrical conductivity level of 86.25μ^{s}/cm . According to Azrina et al (2011), the gap differences with the values of the electrical conductivity of tap water are not yet known but according to Scatena (2000), the differences could be based on agricultural, industrial activities, and frequent land use which obviously affect the mineral contents and hence the electrical content of the water but in the case of Ozoro, it is obviously that of land use for agricultural activity purposes.

Turbidity. Due to variety of particles, water becomes cloudy causing turbidity. Turbidity is the measure of the resistance of water to the passage of light through it and also can be said to be the measure of suspended organic material or soil particles present in it. Turbidity is a key parameter in drinking water analysis. From the study and with reference to table 2 and 3, the results indicated that the turbidity of all the samples studied are below the limits of 5NTU (table 2).

Total Dissolved Solids (TDS). Inorganic matters and trivial amounts of organic matter which are present as solution in water are the total dissolved solids. Table 3 indicates all the 10 sample values of drinking water samples tested and analyzed and all are far below the maximum limits of WHO and NSDWQ (Table 2) recommendations. Alaka and Oda communities have the highest TDS values and Emese has the lowest value of TDS.

Total Suspended Solid (TSS). The samples collected from Alaka, Emese, Oda communities shows very little TSS contents and this is because they have filtration systems attached to the taps, hence removing by filtering, all the particles that are suspended such as clay, silt and most other inorganic particles. The TSS value for Etereva and Esekpe are zero and this is because the sample may have been taken from a treated borehole well. The TSS values of the samples tested (table 3) are all far below the WHO and NSWDQ (Table 2) maximum limit.

Taste and odour. By engaging the use of and the sense of the organs such as the tongue and nostril, all the samples tested organoleptically were of "NO OFF TASTE" and "NO OFF ODOUR" except for Uruamudhu (earthly odour), Alaka (musty odour) and Emese (chlorine odour) which could be no other reason but as a result of chemicals that are dissolved beneath the earth surface in the location where the borehole are drilled.

Minerals and heavy metals analysis. The analysis of minerals and heavy metals in drinking water is a parameter which is very

important and must be investigated because the presence of minerals and heavy metals in human drinking water which is higher and above unquestionable concentration can lead to damaging consequences on human health. In this study, the outcome of the minerals and heavy metals that were investigated are compared with the recommended safe limits of WHO and NSDWQ (tables 2 and table 4) and none is above the limits of WHO or NSDWQ recommendation. In this study and using table 4, the result outcome of the minerals and heavy metals which includes: cu, nitrate ($N0_3$), nitrite ($N0_2$), Fe, Pb, As, cd, Zn, Mg and $C0_3$ (Table 4) are compared to WHO and NSDWQ given standard (Table 2) and can be explicitly observed that they are all below expected maximum safe drinking water quality standard recommended.

Conclusion

From the findings of the study, the values of the water quality conditions or parameters investigated and which includes pH, electrical conductivity, turbidity, TDS, TSS, taste and odour from all the samples from different locations of Ozoro town were and are found to be within the limits (table 3) that are recommended by WHO (table 2) and NSDWQ (table 2).

The concentration of 3 minerals (NO_3, NO_2 and CO_3) and of 7 heavy metals (cu, fe, pb, As, cd, zn and Mg) were also investigated, analyzed and measured and also found to be below the standard maximum concentration (Table 4) of WHO and NSDWQ recommendation (Table 2).

Thus, it is safe to say and recommend that the quality of tap drinking water from borehole is fit and good to drink in all the locations of Uruto, Erovie, Etevie, Urude, Uruamudhu, Alaka, Etereva, Emese, Esekpe and Oda communities of Ozoro town. This is because the physico-chemical parameters and the minerals/heavy metals tested and analyzed were consisted with WHO and NSDWQ standard for drinking water and the process of analyzing is consisted with internationally recognized and acceptable analytical technique in accredited standard laboratory.

Recommendations

It is recommended that in order to assess the overall water quality of Ozoro urban town, it is also important and proper to investigate more water potential contamination which may include microbal, radiological and bacteriological materials including human body fluids.

REFERENCES

Azrina, A., Khoo, H.E., M.A. Idris, Amin, I. and Razman, M.R. (2011). Major inorganic elements in tap water samples in Peninsular Malaysia. *Malaysian Journal of Nutrition,* Vol. 17, No. 2, Pp. 271-276.

Birdie, G. & Birdie J. (2009). Water supply and sanitary engineering. DhanpatRar publishing co. ltd, New Delgi – 110002.

Buswell, A. M. (2003). The chemistry of water and sewage treatment, Chemical Catalog Co., New York.

Dissmeyer, G. E. (2000). *Drinking water from forests and grasslands,* South Research Station, USDA Forest Service, Ashville, NC,

Elango, S.S. (2000). Urban Water Management (Final Thesis). Athlatic International University. Retrieved from http://aiu.edu/publications/student/english/Urban/%20 Water% 20Management

Heckle P &Domek T. (2009): The handbook of water purity and quality available at courses.onlinebooks.google.org.com.ng.

InglezakisI. J &Menegaki A. N (2016): Environment and development available at www. Researchgate.net (2009).

Miller A. P (1999). Water and Man's Health, C.E. and F.N. Spon, London.

Narasimhan T. N: Encyclopedia of inland waters available at www.worldcat.org

Nollet, L.M.I. (2000). *Handbook of water analysis,* Marcel Dekker, New York, NY, USA.

Scatena, F. N. (2000). Drinking water quality in *Drinking water from forests and grasslands: A synthesis of the scientific literature,* G. E. Dissmeyer, Ed., General Technical Report SRS – 39, p. 246, Department of Agriculture, Southern Research Station, Asheville, NC, USA.

UN-Water, (2013). An increasing demand, facts and figures, UN-Water, coordinated by UNESCO in collaboration with UNECE and UNDESA. http://www.unwater.org/water-coopeation-2013/en/.

World Health Organization (WHO). *Guidelines for drinking-water quality,* WHO Press, Geneva, Switzerland, 4th edition.