VARIATION IN WATER PROPERTIES OF SACHET WATER SAMPLES PRODUCED IN EDE, OSUN STATE

Ogenma Ugushida[1], Edet-Utan Oluwakemi[1], ***Ekwonwa C. Esther[1], Kaka M. Oluwatosin[2], Ayodele O. Olubunmi[3,4], Oloyede E, Olayinka[3], Isola F. Bose [5], Adekunle E. Abiodun[3]****

[1]*Department of Public Health, Faculty of Basic Medical Sciences, Adeleke University, Ede-Osun, State.*
[2]*Department of Microbiology, Faculty of Sciences, Adeleke University, Ede-Osun, State.*
[3]*Biotechnology Department, Forestry Research Institute of Nigeria, PMB 5054, Dugbe Ibadan, Nigeria.*
[4]*Nanoscience Department, The Joint School of Nanoscience & Nanoengineering, University of North Carolina, North Carolina 27401, USA*
[5]*Research coordinating Unit, Forestry Research Institute of Nigeria, PMB 5054, Dugbe Ibadan, Nigeria*

ABSTRACT
Thirty (30) pieces of sachet water, _each source with three replicate samples produced in Ede and its environs, were randomly purchased from vendors and analyzed for their variation in water properties. Physical and chemical properties of the water samples were determined to ascertain their portability. Analysis of the chemical parameters such as total hardness, pH level and metal ion contents revealed the contents of the sample were below The World Health Organization (WHO) and The National Agency for Food and Drug Administration and Control (NAFDAC) recommended standards. The pH of all the water samples tested were within the standards of 6.5-9.5 with the lowest at 6.74 and the highest of 7.9. Metal ions, Total Dissolved Solids (TDS) and other parameters determined in the samples also complied with the recommended standards. The conformity of these samples to the basic standard required makes them healthy and fit for consumption.

Keywords: Water properties, Sachet water, metal ions, pH

INTRODUCTION
Water is one of the most important and sufficient compounds of the ecosystem. Every living thing on earth needs water for its survival and growth. Presently, planet earth has about 70% water (Patil et al., 2012). Access to safe drinking water is key to sustainable development and essential to food production, quality health and poverty reduction. But due to increased human population, industrialization, fertilizers used in agriculture and human activity, it is highly polluted with different harmful contaminants. Several small-scale industries are packaging and marketing factory-filled sachet drinking water, popularly called "pure water," that many consider a safer source of potable water (Emmanuel and Solomon 2012). Sachet water is any commercially treated water manufactured, packaged and distributed for sale in sealed plastic bags intended for human consumption (Uduma, 2014).
The sachet water industry has been a key player in the Nigerian economy for about three decades now. They came into existence in the 90s as a result of the inability of the government to make available pipe-borne water. The sachet water 'pure water' is potable water inside conserved polythene, usually in 500ml (50cl) sold for N10. Pure water for the world works in remote and underserved regions of developing countries that lack sustainable, clean and safe drinking water (Stoler et al., 2013). The business of packaging water in this form which was aimed at serving the needs of the poor and transient population initially started in transparent flexible plastic bags, which were manually filled usually with untreated water and knotted by hand. This was referred to as "iced" water. Consequently, the demand for "on the go" water extended beyond the initial demography. However, the questionable sources of water and the poor hygiene of vendors posed severe threats to the health of the drinking populace hence the evolution of "Pure water". .
This study determined the purity and safety of different water samples by assessing their properties in tandem with WHO/NAFDAC standard.

MATERIALS AND METHODS
Study design
The experimental study took place in a biotechnology laboratory, Forestry Research Institute of Nigeria, Ibadan where the following parameters, the pH, Total Dissolved Solids (TDS), Total hardness, Ca, Na, K, Cu, Chlorine, lead, iron, were tested.

Study Setting
Ede is a populated place in Osun State, Nigeria with its southwestern region. It is located at an elevation of 269 meters above sea level, total area of over 3,000 km^2 and a population of 159,866.

Study Samples
Only 30 pieces of sachet water, three from each source to serve as replicate samples, were selected at random and were purchased directly from vendors.

Sample size and sampling technique
This study employed a simple random technique. 30 sachets (10 sachets of different samples and 2 replica sachets of each sample) of water produced in Ede and its environs were purchased at random from various sachet water vendors and transported in ice-packed cooler to the biotechnology laboratory in Forestry Research Institute Ibadan for analysis. The physicochemical parameters assessed include the pH, total dissolved solids, hardness, colour, sodium, calcium, potassium, lead, iron, copper, chlorine, odour and taste.
There is need to show the WHO/NAFDAC standards to be used for comparing the present study here. We don't have to wait to see it in the result section only. This will quick understanding of the results and interpretations.

Water testing procedure for each parameter
Determination of pH
The pH was determined with a pH meter equipped with a glass electrode. The pH meter was calibrated using standard buffers, buffer 4 and 7 and de-ionized water. The electrode was cleaned, dried and dipped into the different samples, and the reading was recorded when the reading became stable. After the pH of the first sample was recorded, the electrode was re-washed with distilled water before being dipped into subsequent samples until all were tested.

Determination of chloride
3 drops of 0.1m potassium indicator was added to 10 mL aliquots of each water sample in a flask and titrated with 0.1m silver nitrate.

Determination of Total Dissolved Solids
Total dissolved solids (TDS) for each water sample was determined mathematically as a product of conductivity multiplied by a constant value, 0.6 (APHA, 1985).

$$\text{TDS} = \text{conductivity} \times 0.6$$

Determination of Heavy Metals
The following heavy metals; Iron (Fe), Lead (Pb), Copper (Cu), Zinc (Zn), Arsenic (As) and Manganese (Mn), were determined for each water sample using Atomic Absorption Spectrometry AAS (Buck Scientific, VPG 210) procedure as reported by Oyelola et al., 2008 and Olaoluwa et al., 2010. Each sample was digested using 100cm3 and a hollow cathode lamp of the desired metal. This was installed into the AAS instrument, and the wavelength characteristics of that metal were then set. The procedure used flame Atomic absorption spectrophotometry using acetylene/air. 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).

Statistical Analysis
The results were statistically analysed using Analysis of variance (ANOVA) operated through SPSS software developed by Microsoft Inc. to determine the variance of the physicochemical parameters of the sachet water samples.

RESULTS AND DISCUSSION
Table 1.0ASSESMENT OF CHEMICAL PARAMETERS

SAMPLES	Na mg/L	K mg/l	Pb mg/l	Fe mg/l	Ca mg/l	Cu mg/l
A	0.16±0.04	3.33±0.4	0.01±0.01	0.05±0.0	23.2±10.2	0.00±0.00
B	0.63±0.09	4.33±1.2	0.01±0.01	0.02±0.00	31.6±6.2	0.00±0.00
C	0.026±0.04	5.00±2.1	0.01±0.01	0.01±0.00	33.3±10.2	0.00±0.00
D	17.46±24.5	6.00±1.4	0.00±0.00	0.01±0.01	38.3±10.2	0.00±0.00
E	0.16±0.12	5.33±2.0	0.00±0.00	0.01±0.01	36.6±6.2	0.00±0.00
F	0.02 ± 0.09	4.66±1.6	0.00±0.01	0.03±0.03	30.0±4.0	0.00±0.00
G	39.35±39.0	5.66±1.2	0.01±0.01	0.02±0.1	42.5±2.5	0.00±0.00
H	0.2 ± 3.4	5.66±2.4	0.01±0.01	0.04±0.02	32.5±2.5	0.00±0.00
I	39.2 ± 39	5.33±2.0	0.00±0.00	0.05±0.04	37.5±2.5	0.00±0.00
J	0.2 ± 0.1	4.33±0.9	0.00±0.00	0.01±0.00	42.5±7.	0.00±0.00

WHO	200	10	0.01	0.3	75	1.0
NAFDAC	200	N/S	0.01	1.0	N/S	0.5

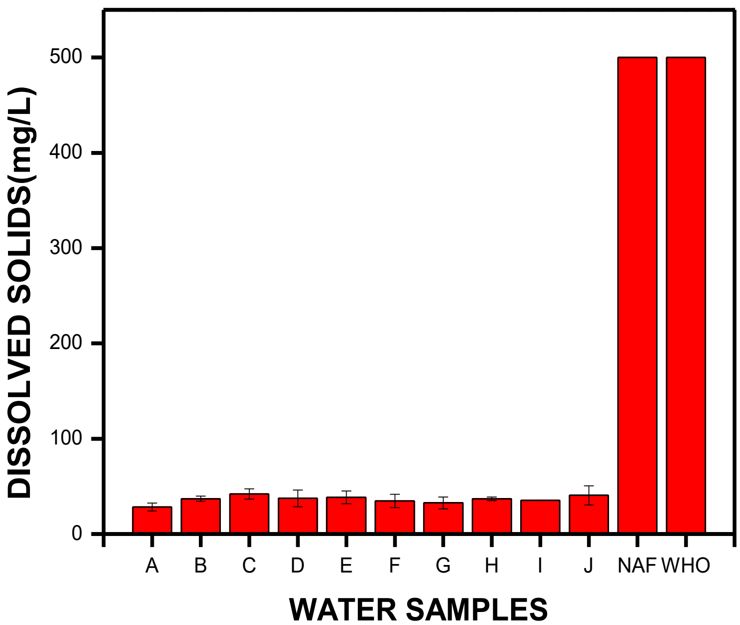

Figure 1: Total Dissolved solids of different sachet water samples produced in Ede compared with WHO and NAFDAC standards.

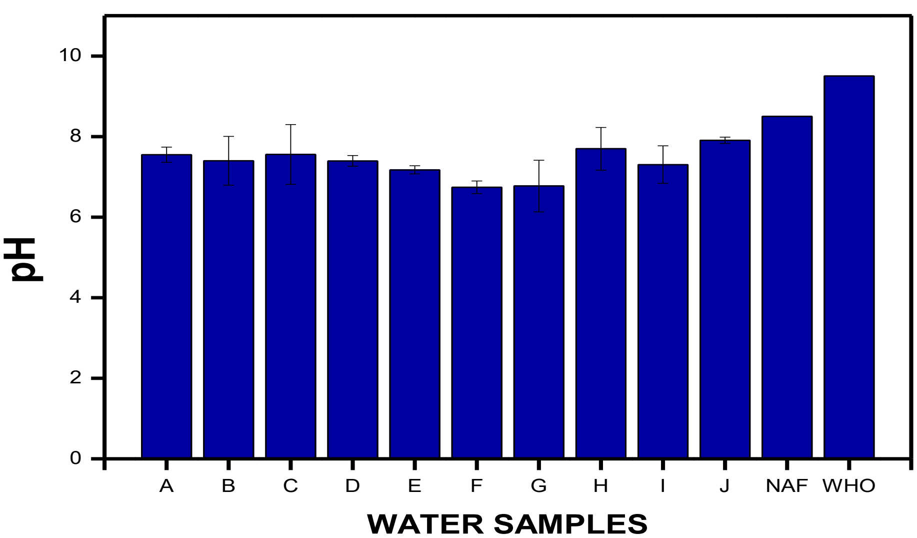

Figure 2. pH level of different sachet water samples produced in Ede compared with WHO and NAFDAC standards.

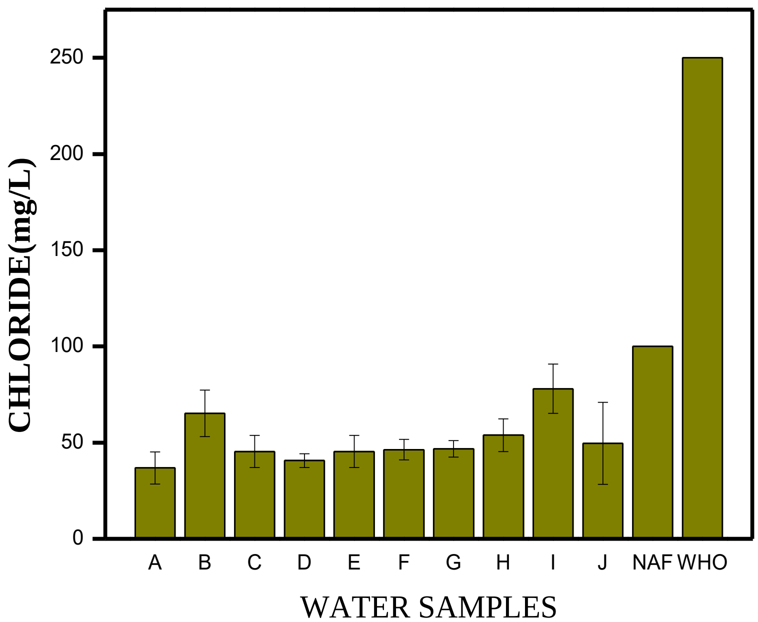

Figure 3.chlorine(mg/L) concentration of different sachet water samples produced in Ede compared with WHO and NAFDAC standards.

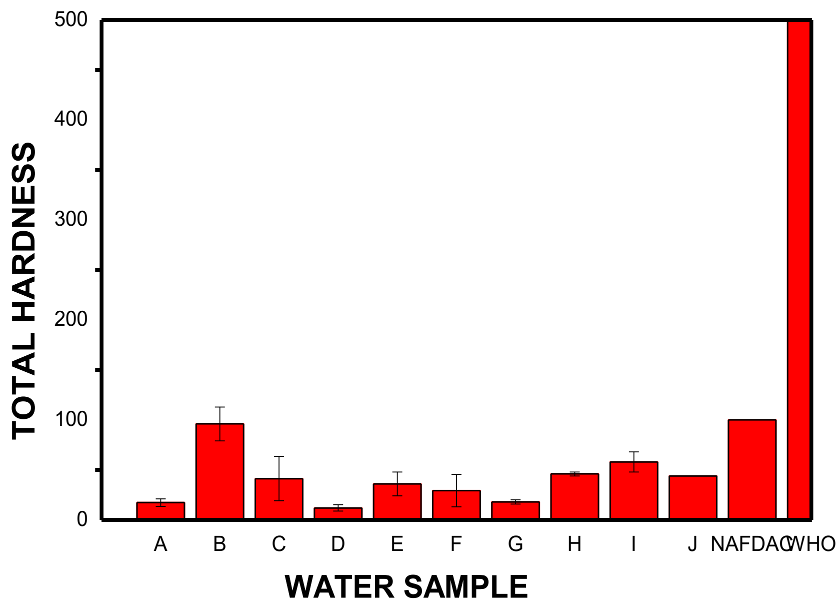

Figure 4. Total hardness (mg/l) concentration of different sachet water samples produced in Ede compared with WHO and NAFDAC standards.

RESULTS AND DISCUSSION

All the chemical parameters analyzed in the sachet water possess acceptable properties of water suitable for consumption and the results obtained are in agreement with a study carried out by Sheshe et al. (2014) on the assessment of the physicochemical quality of sachet water produced in selected local government in Kano, the result of that study revealed that the samples of water tested were odourless, tasteless and their appearance was clear. Water having an odour, taste and unclear appearance has been stated to indicate the presence of potentially harmful substances resulting from pollution or malfunction during water treatment (for instance chlorination) and distribution (Yusuf et al., 2015).

The various chemical parameters analyzed include the total hardness, pH level, chlorine, calcium, total dissolved solids, lead, iron, potassium, sodium, and copper. The total dissolved solids of all the water samples were below the WHO and NAFDAC standards of 500mg/L with the highest value of 41.9 ± 5.4 and the lowest at 32.7 ± 6.2, this can be attributed to the low concentration of other chemicals that make up the total dissolved solids of water (e.g. calcium, potassium, copper) as revealed in the study. This finding is supported by studies carried out by Peter et al. (2015) and Uduma and Uduma (2014) on physicochemical analysis of the quality of sachet water consumed in the Kano metropolis. High TDS can cause a flat, dull taste in drinking water. This was however not the case in this study as the organoleptic assessment of the samples analyzed revealed no insipid taste. This is also revealed in the findings of Magashi and coworkers (2014).

The pH of all the water samples tested was within the WHO and NAFDAC standards of 6.5-9.5 with the lowest pH level of 6.74 and the highest of 7.9 (Figure 2). The result is supported by studies carried out by Martins and Ada (2014) and Ackah et al., (2012). For the total hardness of sachet water, all the samples had low values for total hardness (12 ± 3.2 – 58 ± 10mg/L) except for sample B (96.0 ± 16.9mg/L) (Figure 4) with a value close to the NAFDAC limit of 100mg/L but was also low for the WHO standard, the values obtained fall within the values reported by Shittu et al., (2008). Hardness of water is usually caused by the presence of compounds of calcium and magnesium at the source of water. The low water hardness recorded in these samples could suggest that the water sources the city has less of salts of calcium and magnesium present in them. This implies that calcium for requirements for bone and teeth development of the people of the area of study would come from other sources. Samples A – J fell within the NAFDAC and WHO standard of 0.3mg/L of iron (Fe) the values fell at 0.00 as reported by Abdul et al (2014) in a research carried out by them on the physicochemical properties of sachet water in the Kumasi metropolis of Ghana and therefore poses no health threats.

The result obtained for the chloride as shown in Figure 3 fell within the NAFDAC recommended standard of 100mg/L but was below the WHO standard of 500mg/L as in contrast to a study carried out by Yusuf et al. (2015) the importance of chlorine cannot be overemphasized as it gives a measure of protection against any contamination in drinking water that may occur. (Yusuf et al., 2015). The result of this study as shown in table 1 indicated that the samples tested are in compliance with the recommended lead standard of NAFDAC and the WHO which is 0.01. This result is in contrast with the result of research carried out by Uduma and Uduma (2014) on the physicochemical analysis of the quality of sachet water consumed in Kano metropolis that the lead value fell below WHO recommended standard, they further said the low loads of lead is due to the treatment of water.

The presence of copper in the water supply can interfere with intended domestic uses of water. It increases the corrosion of galvanized iron and steel fittings. Staining of laundry and sanitary wares occurs at a copper concentration above 1mg/L (Yusuf et al., 2015). All the samples were free from copper with a result of the mean and standard deviation of 0.00 ± 0.00. The concentration of potassium(k), sodium (Na) and calcium (ca) were below the NAFDAC and WHO standards, this is supported by studies carried out by Nagamni (2015) on the physiochemical analysis of water samples, and Uduma and Uduma (2014) on the physicochemical analysis of the quality of sachet water consumed in Kano metropolis that the sachet water was below the WHO and NAFDAC threshold limits of (10mg/L) for potassium, (200mg/L) for sodium and (75mg/L) for calcium.

CONCLUSION AND RECOMMENDATIONS

The study revealed that all sachet water samples analyzed produced in Ede met the recommended chemical assessment. Although the sachet water sample's metal content was below the minimum recommended chemical standard. Inhabitants of the area studied could be advised to rely on other sources of dietary intake of important metal ions that are very low in the water available for their consumption. It is not certain most sachet water-producing companies carry out these tests due to its tedious nature and the high cost it involves. The government should also encourage the companies to carry out this analysis and give water-producing industries supervision more priority.

To reduce the effect of poor quality of sachet water, It is therefore suggested that government agencies like NAFDAC/SON should ensure that packaged water manufacturers comply with good manufacturing practices and standards of the physical parameters

REFERENCES

Abdul M., Saah S. A. and Boadi N. O. (2014). Physicochemical and Microbial properties of Sachet Water in the Kumasi Metropolis of Ghana. *Ghana Journal of Chemistry, 2(1) 10-19*

Ackah M., Anim A.K., Gyamfi E.T., Acquah J., Nyarko E.S., Kpattah L., Brown S.E., Hanson J.E.K., Franko J.R., Zakaria N. (2012).Assessment of the quality of sachet water consumed in urban townships of Ghana using physico-chemical indicators *Pelagia Research Library Advances in Applied Science Research* 3 (4): 2120 - 2127

Emmanuel O. O. and Solomon A. (2012) Quality of Sachet Water and Bottled Water in Bolgatanga Municipality of Ghana. Maxwell Scientific Organization, 2012 *Journal of Applied Sciences, Engineering and Technology* 4(9): 1094-1098

Martins O.I. and Ada C. (2014). Quality assessment of various sachet water brands marketed in Bauchi metropolis of Nigeria. *International Journal of Advances in Engineering & Technology* ISSN: 22311963 2489 Vol. 6, Issue 6, pp. 2489-2495

NIGERIAN INDUSTRIAL STANDARD NIS 554: 2007 Nigerian Standard for Drinking Water Quality ICS 13.060.20

Patil P.N, Sawant D.V, Deshmukh. R.N (2012) Physico-chemical parameters for testing of water BharatiVidyapeeth's Near Chitranagari, Kolhapur, Maharashtra, 416013 (INDIA)287. *International Journal of Environmental Sciences* 3 (3), 1194 - 1207

Peter I., Anne G. C. O., Okafor D. C., Eluchie C., Odimegwu N. E., Nze S. N., Anagwu F. I., Okeke K. C. (2015) Assessment of the Quality of Borehole Water Sample in Federal Housing Estate and Sites and Services Areas of Owerri, Imo State, Nigeria. *Food Science and Quality Management* 42: 5 -12

Sheshe, M.U. and Magashi A.M. (2014) Assessment Of Physicochemical Quality Of Sachet Water Produced In Selected Local Government Areas of Kano metropolis, Kano state - Nigeria *Bayero Journal of Pure and Applied Sciences*, 7(2): 31- 35

Shittu, O.B., Olaitan, J.O. and Amusa, T.S. (2008). Physico-Chemical and Bacteriological Analyses of Water Used for Drinking and Swimming Purposes in Abeokuta, Nigeria.African Journal of Biomedical Research, Vol. 11: 285 – 290.

Stoler J, Weeks JR, Appiah O.R (2013). Drinking Water in Transition: A Multilevel Cross sectional Analysis of Sachet Water Consumption in Accra. PLoS ONE 8(6): 1 - 11

Uduma A.U. and Uduma B.M. (2014).physicochemical analysis of the quality of sachet water consumed in Kano metropolis. *American Journal of Environment, Energy and Power Research*, 2(1); 1-10

Yusuf, Y.O., Jimoh, A.I., Onaolapo E.O. and Dabo Y., (2015) An assessment of sachet water quality in Zaria Area of Kaduna State, Nigeria *Journal of Geography and Regional Planning* Vol. 8(7): 174-180.