

Quality Assessment of Sachet Water in Nigeria

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ABSTRACT

This research work was aimed at evaluating the quality of sachet water produced by different organization in Minna metropolis, Niger state Nigeria. Sachet drinking water (often called pure water) is generally accepted safe for consumption. The physical and chemical qualities of ten sachets water sold in Minna town were evaluated to ascertain their compliance with recommendation standards by World Health Organization (WHO) and National Agency for food and drug Administration and Control (NAFDAC). Any of the sachet water brands that fell below WHO drinking water standards are therefore, of bad quality and unfit for human consumption. Physical parameters like the Temperature, pH, Total dissolve solid and Conductivity were determined by instrumental methods. From the physical and chemical results obtained, all samples had values within WHO guided level, rules and procedures, In effect, all the ten samples investigated comply with the standard of WHO to a large extent.

Keywords: water, quality, assessment, sachet

I. INTRODUCTION

Water is a basic requirement for life, water is said to be of good quality if it is odorless, colorless, tasteless and free from biological pollutant (Omalu et al., 2010). An average man (of 53-63kg body weight) required about three liters of water a liquid and food daily to maintain healthy living [onweluzo and Akuagbazie, 2010] this obvious fact account for why water is regarded as one of the most indispensable substances in life. However despite its overwhelming importance and its relative abundance in nature like air, good quality drinking water is readily available to man. The supply of clean source of water is very necessary in order to promote healthy living among the inhabitant of any defined geographical location. However, the standard model for provision and reliable delivery of safe drinking water is not

readily affordable in many developing countries of the world (Dada, 2008). In Nigeria water supply used to be free during the colonial era, but the nation has since undergone a transition from being a mixed economy to a capitalist economy, so water supply now attract rate and fees in most cities and town in Nigeria today [Edema et al.,2011]. Negligence on the part of Nigerian government and insufficient investment in public infrastructure has left the public drinking water supply in Nigeria in an unreliable state [Dada, 2008]. With the insufficient supply of water by government, the private sector participation has evolved and idea of package drinking water popularly referred to as pure water or sachet water, is now a common phenomenon in country. This drinking water is packed in an easy to open, 50-60ml polyethylene leather [Edema et al, 2011]. At present there is an astronomic increase in sales and consumption of sachet drinking water over bottle water, as it is an improvement over the former types of drinking water packaged for sale to consumers in hand filled and tied polythene bags, it is less expensive and also believed to be of high quality than naturally, spring drinking offers a heavy refreshing and exacting test when compared with most high calorie soft drinks and ordinary tap water [Oyedemi et al., 2009]

1.2 Aims and Objectives

The aim of this research journal is to evaluate the physio-chemical characteristic of sachet water in Minna town. This aim can be achieved through the realization of the following objectives.

- Physical examination of the sachet water to assess its NAFDAC number, manufacturing date, best before date, batch number, net volume, nutritional information and producer's name and contact address.
- To determine the physical properties of the sachet water

- To determine some chemical properties of sachet water
- To evaluate statistical analysis of data obtained.

II. MATERIALS AND METHODS

2.1 List of Chemicals/ Reagents used

- Erichrome black T Indicator
- Standard EDTA
- Sodium hydroxide
- HCl
- NH₃ Buffer solution
- Methyl Orange
- NaCl

2.2 List of Equipment and their used

- **pH Meter:** is a scientific instrument that measures the hydrogen-ion activity (acidity or alkalinity in solution)

- **Conductivity Meter:** use for measures the amount of electrical current or conductance in a solution
- **Auto Clave:** it provide a physical method for disinfection and sterilization, it work high temperature and pressure in order to kill microorganisms and spores.
- **Weighing Balance:** is a device to measure weight or mass.
- **Flame Photometer:** is a device used in inorganic chemical analysis to determine the concentration of certain metal ions, among them sodium
- **Oven:** is a device or chamber used for heating materials

2.3 Sampling Location

Table 2.1 Location of Sample Collection

S	A	M	P	L	E	S	L	O	C	A	T	I	O	N												
H	a	p	p	y	d	a	y	s	T	u	n	g	a	M	i	n	n	a								
T	o	p	s	u	c	c	e	s	T	u	n	g	a	M	i	n	n	a								
S	u	p	r	e	m	e	K	p	a	k	u	n	g	u	M	i	n	n	a							
T	w	i	n	s	t	a	r	M	a	i	t	u	m	b	i	M	i	n	n	a						
B	e	t	h	e	l	T	u	n	g	a	M	i	n	n	a											
F	u	t	m	i	n	F	u	t	M	i	n	n	a	b	o	s	s	o	C	a	m	p	u	s		
Z	a	i	l	C	h	a	n	c	h	a	g	a	M	i	n	n	a									
G	o	l	d	e	n	a	g	e	T	u	n	g	a	M	i	n	n	a								
S	a	b	o	b	e	s	t	K	p	a	k	u	n	g	u	M	i	n	n	a						
J	i	d	d	a	m	a	i	n	s	B	o	s	s	o	E	s	t	a	t	e						

Table 2.2 Model of Physical Examination

Sample	Nafdac No.	Best before Date	Manufacturing date	Nutritional Information	Batch NO.	Producer's Name
A 1	+	-	-	-	-	+
A 2	+	-	-	-	-	+
A 3	+	-	-	-	-	+
A 4	+	-	-	-	-	+
A 5	+	-	-	-	-	+
A 6	+	-	-	-	-	+
A 7	+	-	-	-	-	+
A 8	+	-	-	-	-	+
A 9	+	-	-	-	-	+
A 10	+	-	-	-	-	+

Table 2.2 above is the model of physical examination, and this were carried out using a model developed by Dada 2008, where the positive (+) and negative signs were used to donate the presence or absent of the parameter note.

2.4.1 Determination of pH

The pH was first calibrated with buffer solution of pH 7 and 4. After the calibration, the pH electrode was immersed in the water sample contained in a 50 ml beaker and the measurement was read as appeared on the screen of the machine. The reading was allowed to stabilize. The pH electrode was wiped with tissue paper and

2.4 Physio-Chemical Properties of Water

thereafter cleaned with distilled water before dipping into another sample (Sharma et al., 2011).

2.4.2 Determination of Conductivity

The working potassium chloride standard solution was placed in a 50 ml beaker and the conductivity cell was suspended in the solution, holding it approximately 7.5 cm above the bottom of the beaker and making sure that the conductivity cell is not in contact with the wall of the beaker. The conductivity readings were then adjusted to 100 $\mu\text{S}/\text{cm}$. The conductivity cell was then rinsed with distilled water and then the measurement of each sample was read as appeared on the screen.

2.4.3 Determination of Total Hardness

50 ml of water sample was measured using a 50 ml measuring cylinder into 250 ml conical flask. 1 ml of ammonia buffer were then added and a pinch of Eriochrome black T indicator. The sample was properly homogenized and thereafter titrated with standard Ethylene diamine tetra acetic acid. (EDTA) until there was a sharp change in colour from pink to blue (De Zuane, 1996).

Total hardness was then calculated as

$$\text{Hardness as Mg CaCO}_3/\text{e} = \frac{1000 \times 10 \times V_t \times M}{V_s}$$

Where V_t is the amount of titrant needed to reach the end point in ml, M in mg of CaCO_3 equivalent to 1ml of EDTA titrant and V_s is the volume of sample analyzed in ml.

2.4.4 Determination of Total Alkalinity

50 ml of water sample was measured using a 50 ml measuring cylinder into a 250 ml conical flask. The pH of the water sample was measured to determine whether methyl orange or phenolphthalein indicator is to be used. In this case methyl orange was most suitable indicator. 3 drops of methyl orange indicator was added to the sample and homogenized properly to give an orange color. The sample was then titrated against 0.05 m H_2SO_4 until the color change sharply to pink and the volume of titrant was then recorded. Total alkalinity from the titration was calculated using the following expression. Alkalinity ($\text{MgCaCO}_3\text{L}^{-1}$)

$$= \frac{1000 \times V_t \times M}{V_s}$$

Where V_t is the total volume in ml of the acid standard used, M is the mass in (mg) of CaCO_3 in (mg) of CaCO_3 equivalent to 1 ml of titrant (500mgml^{-1} for 0.05 m H_2SO_4) and V_s = volume of sample (ml).

2.4.5 Determination of Sodium and Potassium

10 ml of water sample was measured using a 10 ml pipette into a 50 ml beaker, 20 ml of concentrated nitric acid (HNO_3) were added and was then transferred to boil gently on a hot plate at 110°C until the sample reduces to 5 ml. The sample was then removed from the hot plate and allowed to cool. The sample was then made up to 50 ml with distilled water using a 50 ml volumetric flask. The samples were then analyzed by using flame photometry.

The flame photometry was standardized with potassium and sodium standard before the sample readings were taken. The flame photometry were set to read in $\mu\text{g}/\text{ml}$ equivalent to mg/l .

2.4.6 Determination of Temperature

The temperature of the sample was determined at the commencement of the experiment. This was determined using a common mercury in bulb thermometer ($-10 - 110^\circ\text{C}$) range. The thermometer was dipped in a 50 ml beaker containing the sample in an inclined position for about 5 minute to allow for equilibrium before taking the readings.

2.4.7 Determination of Total Dissolves Solid (TDS)

The total dissolve solid was determined by multiplying the electrical conductivity readings (EC) with a conversion factor. The current conversion factor is 0.64 (www.smart-fertilizer.com).

III. RESULTS AND DISCUSSION

Table 3.1 Result of Physio-chemical parameter of sachet water

Brand code	Temp	Cond.	pH	Hard	Alk	N	a	K	TDS
A 1	27.10	114	7.02	67.00	25.33	10.66	11.38	74.92	
A 2	27.26	100	7.44	73.33	32.33	8.96	9.44	66.26	
A 3	27.7	108.66	6.60	58.66	3	3	13.5	13.73	74.47
A 4	27.3	118.66	6.76	75.33	133.33	8.19	8.39	67.08	
A 5	27.06	115.33	7.17	74.00	3	5	13.70	14.09	76.40
A 6	27.26	101.33	6.93	58.00	29.33	11.64	11.81	67.13	
A 7	28.2	137.33	7.13	71.33	3	2	9.80	9.20	83.09
A 8	27.96	116	6.83	65.33	41.66	11.7	11.53	77.73	
A 9	27.06	106.66	7.11	61.33	42.33	11.55	11.99	70.65	
A 10	28.33	264	7.15	105.33	148.33	11.46	11.56	155.86	
Mean	27.52	128.147	7.014	71.96	55.26	11.12	11.01	81.36	
SD	0.47	49.30	0.24	13.68	45.52	1.77	1.88	26.29	
Minimum	27.06	101.33	6.60	5	8	25.33	8.19	8.39	66.26
Maximum	28.33	264	7.44	105.33	148.33	13.70	14.09	155.86	
Median	27.5	114.67	7.07	69.17	34.00	11.51	11.55	74.70	
Range	27.06-28.33	100-264	6.60-7.44	58-105.33	25.33-148.33	8.19-13.70	8.39-14.09	155.86-74.70	

WHO	28 ± 2	10000	6.5-8.5	150	-	200	-	500
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3.1 Discussion

3.1.1 Temperature

Temperature is a measure of the average thermal energy of a system. The temperatures for all the sachet water samples analyzed were within the range 27.06-28.33 with average value of 27.52. The value obtained for this study is reasonably within the ambient temperature. According to Sunday et al., 2011 temperatures within this range are conducive for optimal growth for mesophyllbacteria including human pathogens; hence this temperature has the potential to enhance the growth of micro-organism thereby promoting the development of unpleasant odour and taste in water. The higher the temperature of water, the lower the level of dissolved oxygen as well as survival rate of micro-organisms. However there are no guideline value recommended for temperature of drinking water (Oparaocha et al., 2010).

3.1.2 Conductivity

Electrical conductivity (EC), also called specific conductance is a measure of the ability of a water sample to convey an electrical current, it is often used to express the numerical content in water (RSC 1999). The result obtained from this

research study indicates that the range obtained is between 100 and 264 micro Siemens which was consistent with the standard value of WHO. Pure water has a conductivity of 1 µs/cm and is not expected to conduct electricity.

3.1.3 pH: is a measure of alkalinity or acidity of water (New school chemistry). pH is an essential parameter required for evaluating the acid-base balance of water (Sharma et al., 2011). pH of the ten brand of sachet water range 6.60-7.44 with an average value 7.01. The pH obtained for these sachet water falls within the set standard of 6.50-8.50. The results also compares favorably with the result of Sunday et al., 2011. The pH of this study tends to fluctuate with week, pH is an important parameter used to ascertain water quality (Sunday et al., 2011). The author also added that micro-organism that frequently changes their pH can either produce acidic or basic metabolic substance as waste.

3.1.4 Total Hardness

Hardness may be considered as a physical or chemical parameter of water. Therefore, it can also be defined as the sum of polyvalent cations present in the analyzed water. Since calcium and

magnesium are normally the only significant ions, hardness is reported as calcium and magnesium in the calcium carbonate form (De Zuane, 1996). Total Hardness obtained from the analysis ranged from 58-105.33mg/l, with the average value 71.96mg/l, compared with WHO values of 0-150mg/l. All the samples had the total hardness concentration within the WHO permissible limit. In other words, hard water requires more soap to produce foam or lather (De Zuane, 1996).

3.1.4 Total Alkalinity

Alkalinity is not a pollutant; it is a measure of the substance in water that has acid neutralizing capacity. From the result of the study obtained, alkalinity ranged from 25.33-148.33mg/l, with the average value of 55.76 mg/l (RSC 1999).

3.1.5 Sodium

Sodium content in the water sample analyzed ranged between 8.19-13.70mg/l with the average of 11.12mg/l. This result falls within the WHO Standard of 200mg/l. This result however, fluctuated from week to week; this may have been caused as a result of microbial degradation in the water sample.

3.1.6 Potassium

The presence of cation in sachet beyond tolerable level has significant health implication. The value of potassium for this study was within the range of 8.39-14.0g with an average value of 11.01. The value tends to decrease with increase in the number of week. According to Sunday et al., 2011 potassium level in water increases when the micro-organism dies. The finding from study shows the presence and active nature of the micro-organism with time for all the samples.

3.1.7 Total Dissolved Solids

The main constituents of the total dissolved solids were calcium, magnesium, sodium, bicarbonates, chlorides and sulphates. Total dissolved solids affect the taste of drinking water if present at levels above the WHO recommended 500 mg/l (Oparaocha et al., 2011). In this research work, the total dissolved solids ranged from 66.26 mg/l-155.86 mg/l, with the average value of 81.36 mg/l falls within the WHO Standard.

IV. CONCLUSION AND RECOMMENDATION

4.1 Conclusion

Based on the studies carried out on this research work, it can be drawn conclusively that

sachet water stored for up to eight weeks do not undergo major physicochemical changes. The result shows that well packaged sachet waters were found to be acceptable for consumption as all the parameters determined were within the WHO and NAFDAC acceptable limit.

4.2 Recommendation

Future research should be carried out in, to ascertain the presence of heavy metals dissolved in the water samples specifically for the effects of radiation from the polythene into the water.

Also further research should be carried out on other cities and town in Niger State as the situation could be different.

Other parameters such as Turbidity, Colour, Taste, Odour, Nitrite, Nitrate, Sulphate, Iron, Calcium, Chlorine etc. should be carried out in further research.

REFERENCE

- [1]. Ababio, O. Y.(2007) New School Chemistry. Office press, Limbe Souyh West Province, pp. 296-298.
- [2]. Amoo G.F (2007): Evaluation of Packaged Water sold in Minna metropolis, B.Tech thesis, Department of Chemical Engineering, Federal University of Technology, Minna, Niger state.
- [3]. Dada, A.C.(2009). Sachet Water phenomenon in Nigeria: Assessment of the potential health impacts. African Journal of Microbiology Research, Vol.3(1) pp. 015-021, Available online <http://www.academicjournals.org/ajmr>.
- [4]. De Zuane (1996): Handbook of Drinking Water Quality, New York City, Department of Health D.T.E AhiPg 7-40.
- [5]. Dekker, M. N. (2000). Ion Exchange-Wikipedia, The Free Encyclopedia. Retyrived from http://en.Wikipedia.org/wiki/water_treatment_methods on 25th August, 2010.
- [6]. Edema M.O, Atayese. O.A and Bankole, M.O (2011). Pure water syndrome: Bacteriological Quality of sachet-packed drinking water sold in Nigeria. African Journal of Food Agriculture Nutrition and Development Vol.11(1) 4596-4609.
- [7]. Sharma Shraddha, Vishwakarma Rakesh, Dixit Savita and Jain Praveen (2011)
- [8]. Evaluation of Water Quality of Narmada River with reference to Physicochemical Parameters at Hoshangabad city, MP, India, Research Journal of Chemical Sciences Vol. 1(3) 40-48.

- [9]. Sobsey M.D and. Pfaender F.K. (2002). Evaluation of the H_2S method for detection of fecal contamination of drinking water. WHO/SDE/WSH/02.08 © 2002, WHO Retrieved April 24, 2007, from http://www.who.int/water_sanitation_health/dwq/WSH02.08.pdf
- [10]. McGraw, H.N.(1962). Ion Exchange- Wikipedia, the free encyclopedia. Retrived from http://esn.Wikipedia.org/wiki/water_treatment_methods on 25th August, 2010.
- [11]. Mihayo I. Z. and Mkoma S.L.(2010). Chemical water Quality of Bottled Drinking water Brands Marketed in Mwanza City, Tanzania.
- [12]. Miraslav R. and Vladimir N. The Royal Society Chemistry, 1999. Milton Road, Cambridge, UK.
- [13]. Muazu Sagir Y.,(2011). Study of Quality of Treated water in Water Treatment Plants: A Case Study of Bosso and Chanchaga Water Treatment Plants in Minna. Undergraduate Thesis, Department of Chemical Engineering, Federal University of Technology Minna, Nigeria pp.5-28.
- [14]. Murhekar Gopalkrushna H.(2011) Assessment of Physico-Chemical Status of Ground Water Samples in Akot city, Research Journal of Chemical Sciences Vol. **1(4)**, 117-124.
- [15]. Murray K.W. Water Quality (2000). http://en.wikipedia.org/water_treatment.
- [16]. Nana Asamoah and R. Amarin(2011) Assessment of the Quality of Bottled/Sachet Water in the Tarkwa-Nsuaem Municipal(TM), Research Journal of Applied Sciences, Engineering and Technology 3(5): 377-385.
- [17]. Omalu, I.C.J; Eze, G.C; Olayemi, I.K; Gbesi, S; Adeniran L.A, Ayanwale, A.V, (2010) Water in Nigeria: Assessment and Health Impact. Online J Health Allied Scs.;9(4) available at <http://www.ojhas.org/issue36/2010-4-15.htm>.
- [18]. Onweluzo, J. C. and Akuagbazie, C.A (2010): Assessment Of The Quality Of Bottled And Sachet Water Sold In Nsukka Town, **Agro-Science** Journal of Tropical Agriculture, Food, Environment and Extension Volume 9 Number 2 pp. 104 – 110.
- [19]. Oparaocha E.T, Iroegbu, Obi, R.K. (2010). Assessment of quality of drinking water sources in the Federal University of Technology, Owerri, Imo state, Journal of Applied Biosciences 32: 1964 – 1976.
- [20]. Oyedeji, O; Olutiola, P. O and Moninuola, M.A. (2010): Microbiological quality of packaged drinking water brands marketed in Ibadan metropolis and Ile-Ife city in South Western Nigeria, African Journal of Microbiology Research Vol. 4(1) pp. 096-102, Available online <http://www.academicjournals.org/ajmr>.
- [21]. WHO (1984) Guideline for Drinking Water Quality, Vol. 2 Retrieved from <http://search/water> quality requirement on 2nd August, 2010

APPENDIX

Standard deviation of the sample is calculated

using the below relation $S.D = \sqrt{\sum(X - \bar{X})^2} \div n - 1$

Where S.D = Standard deviation

X = Value of sample

\bar{X} = Mean of the sample

n = Number of samples

$\bar{X} = \sum Fx \div N$

$\bar{X} = 27.52$ and $N = 10$ For Temperature

S.D = 0.486

Ti HARD

$\bar{X} = 71.96$

$N = 10$

S.D = 13.68

ALKALINITY

$\bar{X} = 55.26$

$N = 10$

S.D = 45.52

SODIUM

$\bar{X} = 11.12$

$N = 10$

S.D = 1.777

POTTASSIUM

$\bar{X} = 11.01$

$N = 10$

S.D = 1.88

TDS

$\bar{X} = 81.36$

$N = 10$

S.D = 26.29

The medium is also calculated using the below relation

$X_{med} = N_1 + N_2 \div 2$

ALKALINITY

$X_{med} = 34$

Sodium

$X_{med} = 11.505$

Pottassium

$X_{med} = 11.545$

TDS

$X_{med} = 74.69$