WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 7.523
Volume 6, Issue 8, 86-95. Research Article ISSN 2277– 7105

QUALITY ASSESSMENT OF SELECTED SACHET WATER SOLD IN UYO METROPOLIS, NIGERIA

Grace Micheal Ikon[1], Promise Ifunanya Ohagim[2]*, Chijioke Patrick Amadi[2] , Victor Nelson Abasiubong[2], Etang Ubong Ekerenam[2] and Ekanemesang, M. Udoudo[1]

[1]Department of Microbiology, Obong University, Obong Ntak, AkwaIbom State.

[2]Department of Medical Microbiology and Parasitology, University of Uyo, Akwa Ibom State.

Article Received on
29 May 2017,

Revised on 19 June 2017,
Accepted on 10 July 2017

DOI: 10.20959/wjpr20178-8900

***Corresponding Author**
Dr. Promise Ifunanya Ohagim
Department of Medical Microbiology and Parasitology, University of Uyo, Akwa Ibom State.

ABSTRACT

Sachet water is any water commercially treated, packaged and Distributed for sale in sealed nylon or cellophane bags, intended for human consumption. Its distribution in Nigerian markets is seen as a less expensive means of accessing drinking water than bottled water. This study was carried out to assess the physicochemical and bacteriological composition of the sachet waters sold in Uyo. A total of 100 samples from 10 brands of sachet water were collected randomly from (hawkers/vendors) in Uyo metropolis of Nigeria. The physical, chemical and bacteriological analysis were determined and compared with the WHO acceptable standards. Physicochemical tests were done using standard qualitative spectrophotometric and titrimetric analysis. The assessment and enumeration of coliform and other indicator organisms was done using Standard microbiological techniques. The results showed that physical and chemical parameters were within the WHO and NIS standard limit for potable drinking water. Bacteriological analysis showed that coliform count of all the sachet water samples did not conform to the WHO standard, while 70% of the samples conformed to NIS standard. Hence, the overall results showed that the sachet water produced in the study area are relatively safe for drinking according to the WHO standard for potable water while 70% of the sachets water was safe for drinking according to Nigerian Industrial standard. The result of this study recommends the establishment of a task force in the state that would look into the quality of water products in circulation, with emphasis on the bacteriological compositions.

KEYWORDS: Quality analysis, sachet water, Uyo.

INTRODUCTION

Water is an essential natural resource for the sustainability of human and animal lives on earth. Humans can survive for several weeks without food, but can endure only for about few days without water. This is because water is needed to replenish fluid which is lost during normal body activities including urination, perspiration and respiration.[1] Only about 0.3% of the estimated 1.36 billion Km^3 of the hydrosphere is fresh water, which is found in rivers, streams, springs and aquifers with the remaining 99.7% locked up in seas and oceans.[2] Several studies have shown an increase in the demand for freshwater due to rapid growth of population as well as the accelerated pace of industrialization in the last few decades.[3] All water contains varying level of impurities. As water flows in streams, accumulates in lakes and filters through layers of soil and rock in the ground, it dissolves or absorbs substances it comes in contact with, which may be harmful or harmless.[4] The availability of potable water to the entire populace has emerged as one of the critical problems facing most developing countries of the world today.[5] The National Agency for Foods and Drugs Administration and Control (NAFDAC) in Nigeria has made the provision of drinking water, safe and aesthetically acceptable as a major goal of the organization. An acceptable drinking water should meet the World Health Organization (WHO) standard for human consumption, being free from physical and chemical substances and microorganisms in an amount that cannot be hazardous to health.[6] There is no single method of purification that can eliminate 100% contaminants from drinking water, nor make it safe for consumption within acceptable limits.[6]

Sachet water is any water commercially treated, packaged and distributed for sale in sealed food grade containers intended for human consumption. Sachet water distribution in Nigerian markets is seen as a less expensive means of accessing drinking water than bottled water. Its production and introduction into Nigeria dates at the late 90s and today, is seen as one of the fastest growing industries in the country, due to the advancement in the technological method of purification and packaging. Most individuals that consume water are unaware of the potential health implications associated with exposure to water-borne contaminants, which often lead to water-borne diseases such as cholera, dysentery, diarrhea, legionnaires, typhoid fever and parasitic diseases.[7] The increase in the sale and indiscriminate consumption of

package water in Nigeria is of public health importance as the prevalence of water related diseases in developing countries is determined by the quality of their drinking water.[8]

There has been countless number of disease outbreak and poisoning around the world resulting from the consumption of untreated or poorly treated drinking water.[9] Pure water is colourless, odourless and tasteless. With a high boiling and melting points as well as high heat of vapourization. It can be slightly ionized reversely to yield hydrogen and hydroxyl ions. Therefore, water is not just a solvent in which the chemical reactions of the living cell occur.[10] The quality of potable water is evaluated based on its chemical constituents. This is carried out by assessing the hardness, pH, total alkalinity, dissolved oxygen, carbon dioxide, heavy metals and organic constituents.[6]

The consumption of sachet water is on the increase in Uyo, irrespective of whether they have NAFDAC certification or not. However, despite the strong effort by NAFDAC in the regulation and quality assessment of sachet water, there is still a growing number of reported public illnesses after drinking sachet water.[3] Several studies on the quality of sachet water have reported violation of international quality standards. According to the Institute Public Analyst of Nigeria (IPAN), 50% of the sachet water sold in the streets of Lagos may not be fit for consumption.[11] Therefore, there is every possibility that the same scenario will play out in other cities across the country including Uyo metropolis. There are numerous brands of sachet water in Uyo metropolis at the time of this study; hence the accurate number was difficult to be tracked down. People who have patronized sachet water continue to ask questions on the purity of this water. This study tries to provide information on the quality of sachet water sold in Uyo, Southern Nigeria.

MATERIALS AND METHODS

Study Area

This study was conducted in Uyo, Akwa Ibom State, South-South region of Nigeria. Uyo metropolis has a population size of about 805,451(census report, 2006) and is seen by many as a fast growing city both economically and population wise. The city lies between latitude 5.5^{o}N and 6.0^{0}N, and longitude 6.0^{o}E and 6.5^{o}E of the Greenwich Meridian. It is located in the rain forest belt with elevation of less than two feet above sea level. With its status as a developing capital city, it is surrounded by several sub-urban and rural communities. The maximum temperature experienced is between 26-28^{o}C and annual rainfall of about 362.5mm

(Canback Dangel Database). The climate present two distinct seasons; a rainy season (May to October), and a dry season (November to April).

Sample size and sample collection

Ten samples each from ten (10) brands of sachet water were examined, giving a total of 100 samples analysed. The ten brands were Blink sachet water, Emprebs water, Harmony water, Holy Saviour water, Juumavin water, Leemas water, Marvina water, Ndumex water, Toopex water and Usmer sachets water which were selected randomly from hawkers and those selling in shops and supermarkets on different days, so as to obtained water products sealed on different days. It is of great importance to note that all samples collected for analysis accurately reflect their conditions at the time of sampling. The samples were collected in clean coolers and transported to the laboratory where they were stored at room temperature until used. It was ensured that no openings were created on the nylon or cellophane sachets which may create ways for spillage and extraneous contaminations.

Physical analysis

These include determining the temperature, pH, colour, odour and turbidity of the water samples.

The temperature of all samples was ascertained using a simple mercury-in-glass thermometer as described by Edema *et al*[12] and Dinrifo *et al*[13] this was carried out in-situ at the site of sample collection by dipping the thermometer into the sample and recording the stable reading. The turbidity of the water samples were ascertained using a turbidometer (HANA instrument HI93703) expressed in whole number as Nephelometric turbidity unit (NTU).[14,13,15] The colour of all the water samples was determined using a colour kit (Lovibon comparator, 2000 visual). A tube of the Lovibond comparator matched tube was filled with a water sample to be examined and the other tube filled with distilled water which was used as a control. Both tubes were placed in a comparator, adjusted by rotating the disc until the nearest colour match was observed. The results was then expressed in whole number and recorded as Hazen unit.[13] The pH of the water samples was determined using a pH meter (Toledo, MP220). Each water sample was transferred into a 100 cm3 beaker and the pH determined by inserting the pH meter probe after standardization and the readings taken. The standardization of the meter was ensured after each water sample reading.[16]

Chemical analysis

This was carried out to determine the hardness, total dissolved solids, conductivity rate, and the dissolved oxygen in the water samples. The hardness of each water sample was ascertained using a UV-visible spectrophotometer (HACHD 89) in which each of the water sample was pipetted into a sample cell and total hardness reagent H-1K added and allowed to stand for 3-5 minutes. The result of the total hardness of the samples was obtain after the reactions.[16] The Total dissolved solids (TDS) for each water sample was determined mathematically as a product of conductivity multiplied by a constant value, 0.6; TDS = conductivity x 0.6.[16] The Conductivity of the water samples was ascertained using a digital conductivity meter model 4520 JENWAY, with the serial No 01263. The meter was warmed up for about 15 minutes after switch on, and then standardized with 0.01M KCI solution giving a conductivity value of about 1413 micro-siemen per centimeter. The electrode was rinsed thoroughly using distilled water and then introduced into the water samples and the value of each sample obtained.[17] The acidity of the water samples was determined by titration, following the guidelines in the American society for testing and materials (1982). 50mL of the sample was pipetted into a clean 250mL conical flask. Two drops of phenolphthalein indicator were then added and the solution titrated against a standard 0.01M NaOH solution to a pink end-point. The alkalinity of the samples was also determined using titration method. A 50mL of the sample was pipetted into a clean 250mL conical flask. Two drops of methyl red indicator were then added and the solution titrated against a standard 0.01M NaOH solution to a pink end-point.[16] The dissolved oxygen in the water samples was determined using Winkler's method. In this procedure, an excess of Manganese (II) salt, iodide (I-) and hydroxide (OH-) ions were added to the samples which resulted to a white precipitate of Mn $(OH)_2$. The precipitate was then oxidized by the dissolved oxygen in the water sample into a brown Manganese precipitate. A strong acid (hydrochloric acid) was added to acidify the solution. The brown precipitate then converted the iodide ion (I-) to iodine. The amount of the dissolved oxygen was directly proportional to the titration of iodine with a thiosulphate solution.

Microbiological Analysis (coliform count)

Bacteriological analysis was carried out using the Pour Plate, Membrane Filtration and Most Probable Number (MPN) methods based on the World Health Organization standard method of analysis.[18]

RESULT

The physicochemical characteristics of the 10 sachet water brands are shown in Table 1 below. All the physical and chemical composition of the water brands was within the WHO and NIS standard limits. With the pH of the water brands within the WHO standard of 6.50-8.50, the conductivity within the range of <1000µs/cm, the total dissolved solids within<1000mg/l, hardness with $CaCo_3$ within <150mg/l, the free residual chloride within <0.25mg/l, the chlorides <250mg/l. the heavy metals were within the stipulated range by WHO standard. Iron was found to be present in all the water brands. The BOD and OD were within range. All the water brands were colourless, odourless, tasteless and clear.

Table 1: physicochemical characteristics of the 10 sachet water brands

Parameters	BTW	EMW	HMW	HSW	JMW	LMW	MVW	NDW	TPW	USW
pH	6.56	6.54	6.57	6.65	6.75	6.75	6.65	6.52	6.00	7.05
Conductivity (µs/cm)	49.0	62.0	77.0	47.0	26.0	130.0	36.0	33.0	46.0	144.0
Total Dissolve Solids (mg/l)	10.0	34.0	43.0	25.0	14.0	74.0	21.0	18.0	8.0	82.0
Hardness ($CaCo_3$) (mg/l)	13.50	33.0	33.0	24.0	6.0	63.0	25.51	21.0	7.0	45.0
Free Residual Chlorine	0.05	0.05	0.02	0.03	0.04	0.05	0.02	0.02	0.03	0.04
Chlorides	46.0	59.72	61.3	51.20	55.20	64.50	62.40	46.51	54.60	93.00
Potassium	3.0	6.50	6.50	8.0	5.5	6.0	4.5	8.0	7.5	5.5
Nitrates	1.0	4.2	2.4	1.9	1.9	3.7	7.0	5.9	6.4	2.5
Calcium	6.92	20.09	19.66	14.17	3.24	28.24	13.62	11.76	3.69	23.81
Magnesium	0.12	0.14	0.15	0.14	0.11	0.16	0.16	0.13	0.12	0.16
Iron	0.381	0.128	0.02	0.014	0.39	0.36	0.24	0.03	0.03	0.04
Zinc	0.23	0.31	0.31	0.26	0.22	0.28	0.29	0.22	0.23	0.31
Turbidity(NTU)	1.00	1.05	1.65	0.65	0.72	1.11	1.12	0.16	0.62	0.70
BOD (mg/l)	0.3	0.9	1.2	1.8	0.9	0.6	0.7	0.6	0.8	0.11
OD(mg/l)	0.4	1.2	0.9	0.5	1.3	1.4	0.6	0.7	1.1	1.5

Keys: BTW = Blink table water, EMW = Emprebs water, HMW = Harmony water, HSW = Holy Saviour water, JMW = Juumawin water, LMW = Leemas water, MVW = Marvina water, NDW = Ndumex water, TPW = Toopex water, USW = Usmer water, BOD = Biological oxygen demand.

The result of the coliform count for the ten sachet water using most probable number (MPN) **is** represented in Table 2 below. None of the water brands met the WHO standard of zero (0) coliform, while seven out of the ten met the NIS standard of below 10 coliforms. With the water brand USW having the highest number of coliform colonies present. The four brands EMW, HSW, MVW and NDW had the least possible coliforms being less than two colonies.

Table 2: coliform count for the ten sachet water using most probable number (MPN)

S/No	Samples	10ml	1ml	0.1ml	MPN/100ml
1	BTW	2	0	0	5
2	EMW	0	0	0	<2
3	HMW	1	0	1	4
4	HSW	0	0	0	<2
5	JMW	1	0	0	2
6	LMW	3	0	0	12
7	MVW	0	0	0	<2
8	NDW	0	0	0	<2
9	TPW	2	2	0	11
10	USW	3	0	1	13

Keys: BTW = Blink table water, EMW = Emprebs water, HMW = Harmony water, HSW = Holy Saviour water, JMW = Juumawin water, LMW = Leemas water, MVW = Marvina water, NDW = Ndumex water, TPW = Toopex water, USW = Usmer water,

DISCUSSION

Potable water should be free from chemicals and microorganisms; its physical state must meet with the generally acceptable standard. The physical parameters analysed in the sachet water samples include odour, taste and colour. These quality assessing parameters affects the acceptability of water for consumption.[19] The water samples from the different brands were all clear, odourless, colourless and tasteless. This could be as a result of the filtration methods involving sand and activated carbon filtration employed during sachet water production by most companies. The conductivity value in all the water samples tested were within the acceptable limit of less than 1000µs/cm as stipulated by NIS, 2007 standard. This is similar to the result obtained in Owerri Metropolis and five Local Government Areas of Nasarawa state by Nwosu *et al.*[20] and Sheshe *et al.*[21] in which their conductivity were below 1000µs/cm. Total dissolved solids (TDS) of 10.0 to 82.0mg/l was obtained from the sachet water samples, which are within the acceptable limit of 500mg/l as recommended by the NIS, 2007 and WHO, 2004 standards. This is similar to that obtained in Owerri and Lagos Metropolis by Nwosu *et al.*[20] The total hardness of the water samples obtained was within the range 6.0-63.0mg/l. These values are within the recommended limit of 150mg/l by NIS, 2007 and WHO, 2004 standards. World Health Organization classified every water <150mg/l CaCO3 as soft and >150mg/l CaCO3 as hard. All the water samples in the study were soft and fit for consumption. This is in line with the result obtained from a similar work carried out in Nsukka town by Onweluzo *et al.*[4] in which a total hardness below 6.8mg/l was obtained. All the chemicals tested for were all within the WHO acceptable standard limit. The

quantity of the heavy metals tested conformed with the WHO, 2004 and NIS, 2007 standard limit. All the sachet water samples but three(30%) had an Iron (Fe) quantity which were within the specified NIS, 2007 standard limit of <0.3mg/l. This high level of Iron (Fe) in water can be traced to possible dissolution of iron bearing rocks through leaching as the water moves down the water table. A similar result was reported in a work carried out in Abeokuta, Ogun State, Nigeria by Taiwo *et al*.[22], who reported traces of Iron (Fe) in some sachet water samples. The results of BOD and OD obtained were all within the WHO and NIS limit of ≤10 and ≤5 respectively. These results show that none of the ten (10) samples analysed for coliform count were within the WHO standard for drinking of zero (0) coliform, while seven (7) sachet water samples were within the NIS standard of <10 coliform count. This means that all the water samples contain coliforms, suggesting that there could be some health implications pending on the type of coliform found. The presence of these coliforms could be as a result of the poor sanitary nature of the various places of production.

CONCLUSION

The analysis of sachet water quality produced and sold in Uyo metropolis, via physicochemical and microbilogical assessment indicated that physical parameters such as appearance, colour, taste and pH conformed to the acceptable standards. Chemical properties such as conductivity, total hardness and nitrate, total dissolved solids, fluoride, BOD, OD and heavy metals such as Magnesium, zinc and calcium were in line with the requirements of WHO and NIS standards. It can be concluded from the result of this study that the physicochemical parameters tested in all the sachet water samples were within the permissible limits stipulated by the drinking water standards, except coliform count which did not conform to the WHO standard, while 70% of the samples conformed to NIS standard. Hence, the overall results showed that the sachet water produced in the study area are relatively safe for drinking according to the World Health Organization standards for potable water while 70% of the sachets water was safe for drinking according to Nigerian Industrial standard.

REFERENCES

1. Adefemi OS, Asaolu SS, Olaofe O. Assessment of the physicochemical Status of water samples from Major Dams in Ekiti State, Nigeria. *Pak. Nut*., 2007; 6(6): 657-659.
2. Muhammad BG, Ismail BS, Ekhwan T, Sujaul IM, Tan CC. A physico–chemical assessment of the Behar River" Pahang, Malaysia. *Global journal of Environmental Research*, 2007; 1: 07-11.

3. Ogamba AS. Packaged drinking water, how safe? *Professionalism IPAN News*, 2004.
4. Onweluzo JC, Akuagbazie CA. Assessment of the Quality of Bottled and Sachet water sold in Nsukka town, Nigeria. *Journal of Agriculture, Food, Environment and Extension*, 2010; 9(2): 104-110.
5. Kulshershtha SN. A global outlook for water resources to the year 2005. *Water Resourc. Manage*. (WRM), 1998; 12(3): 167-184.
6. Denloye SA. Quality parameters for packaged water, NAFDAC Laboratory Experience. *IPAN News*, 2004.
7. Omalu ICJ, Eze GC, Olayemi IK, Gbesi S, Adeniran LA, Ayanwale AV, Mohammed AZ, Chukwuemeka V. Contamination of sachet water in Nigeria: Assessment and health impact: 2011; online paginated.
8. Ezeugwunne IP, Agbakoba NR, Nnamah NK, Anhalu IC The Prevalence bacteria in packaged sachet water sold in Nnewi, South East, Nigeria. *World J. Dairy, Food Sci.*, 2009; 4(10): 19-21. Http//:www.grinningplanet.com/pollution.html. Retrieved 20th February, 2014.
9. Fong TT, Mansfield LS, Wilson DL, Schwab DJ, Molloy SJ, Rose JB. Massive microbiological ground water contamination associated with a water borne outbreak in lake Eric, South Bass Island, Oshio. *Environmental Health Prospect*, 2007; 155: 856 - 864.
10. Talwar GP, Strivastava LM, Mougil KD. Biochemistry and Human Biology. 2nd edition, 1989.
11. Osibanjo O, Ajayi S, Adebiyi F, Akinyanju P. Public Analysis Reporting System as Applied to Environmental Issues. IPAN News, A Publication of the Insitute of Public Analysts, 2000; 1(3): 10.
12. Edema MO, Omemu AM, Fapetu OM. Microbiology and physicochemical analysis of different sources of drinking water in Abeokuta, Nigeria. *Nigerian Journal of Microbiology*, 2001; 5: 57–61.
13. Dinrifo RR, Babalunde SO, Bankole YO, Demu QA. Physicochemical properties of rain water collected from some industrial areas of Lagos State, Nigeria. *European Journal of Scientific Research*, 2010; 41(3): 383–390.
14. Essien EB, Olisah AC. Physicochemical and microbiological quality of water samples in three Niger Delta States, Nigeria. *Journal of Pharmacy Research*, 2010; 8(3): 1844–1847.

15. Olaoluwa OJ, Olubukola OA, Deborah DO, Oluwanike O, Oluwaloyin I, Oladipo, A. Incidence of drug resistant bacteria and physicochemical properties of Ero Dam, Nigeria. *Report and Opinion,* 2010; 2(12): 78.
16. American society for testing and materials Standard methods for acidity or alkalinity of water, 1982; Publ.D1067-70 (reapproved 1977), American soc. Testing and materials Philadelphia.Pa.
17. Bennet DP, David AH. Introduction to Field Biology 2nd Edition, Macmillan Publishing Company, Glasgow, Great Britain, 25: 1974.
18. World Health Organization. Guidelines for drinking water quality. Health criteria and other supporting information 2nd ed., 2011; 2. Geneva: WHO; Available from: http://www.who.int/watersanitationhealth/dw.q/ 2edvolp1.pdf. [Last accessed on 2015, February 28].
19. Yakasai HM, Atiku MK. Study on Physicochemical Characteristics of Industrial Effluents from Bompai Industrial Areas, Kano Metropolis. *Best Journal,* 2010; 7(3): 81-86.
20. Nwosu JN, Ogueke CC. Evalution of Sachet Water Samples in Owerri Mertopolis. *Nigerian Food Journal,* 2004; 22: 164-170.
21. Sheshe MU, Magashi AM. 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*, 2014; 7(2): 31-35
22. Taiwo AA, Idowu O, Lanre-Iyanda YA, Jolaoso AA, Jiboku OO, Ijaola TO, Taiwo AG. Physico- chemical and Bacteriological Analysis of sachet water samples in Abeokuta Metropolis, Nigeria. *Global Advance Research Journal of Agricultural Science*, 2012; 1(1): 1-6.