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Physicochemical and Microbiological Analysis of Selected Sachet Water Vended in Akure, Ondo State, Nigeria

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Abstract: *There is increase demand for sachet water as a result of non-availability of reliable safe drinking water and this has left the impression that most sachet water offers a healthy, safer and water with better and good quality. Despite general acceptability of packaged sachet water, previous work showed that there is a challenge associated with its quality as a result of isolation of some microbes and non-compliance with expected parameters. The current work is focus on physicochemical and microbiological analysis of selected sachet water vended in Akure, Ondo State, Nigeria. Five samples of sachet (A= Primus table water; B= Bofa table water; C= Zion table water, D=Aktols table water and E=Edna table water) water obtained from five different areas were analyzed for physicochemical and microbiological parameters using standard analytical methods of Association of official Analytical chemists (AOAC). The result of microbial analysis revealed that all the water samples referred to as samples A, B, C, D and E respectively had total plate count of 7.0cfu/ml, 4.0cfu/ml, 1.0cfu/ml, 15.0cfu/ml, and 3.0cfu/ml respectively. This showed that sample A, B, C, D, and E did not exceed the standard of total plate counts. The entire samples resulted at 0 counts for Escherichia coli. Samples A, B, C, D and E tested negative for Coliform test, Fungi test and Salmonella shigella test. The chemical analysis showed that all the samples meet up with the recommended standard of pH (6.5-8.5) by World Health Organization (WHO), United Nations International Children's Emergency Fund (UNICEF) Standard ganization of Nigeria (SON) and National Agency for Drug and Administration Control (NAFDAC). The temperatures were not significantly different and did not exceed standard limit of 37^0C. The total dissolved solid also did not exceed the limit of 500ppm as recommended by World Health Organization /United Nations International Children's Emergency Fund (WHO/UNICEF) and the conductivity limit was not exceeded. All the samples did not exceed limits for zinc, chloride, iron, nitrate, nitrite and flouride which are 0.3mg/l, 250mg/l, 0.3mg/l, 50mg/l, 0.3mg/l and 15 mg/l respectively. All the samples were significantly different for each parameter except for lead, copper, free chlorine and manganese of which the entire sample were all the same.*

Keywords: Sachet water, Physicochemical, Microbiological, Coliform bacteria and Nigerian Industrial Standard

1. INTRODUCTION

Current challenges facing world is unavailability of portable water for human consumption. The existence and survival of human, animals and plants has been linked to water [1, 2]. Apart from other activities that human cannot do without water, drinking of clean, hygienic water devoid of particles and contamination by microbes is also paramount for good health and human growth. Water is one of the most important needs of all forms of life and is unavoidable in man's daily life, constituting a sizeable percentage of man's daily food intake because human bodies do not have reserve supply [3]. It is also an essential requirement of life for drinking, domestic, industrial and agricultural uses [4]. People view water under varied perspective due to its availability in several places but major concern is getting pure and clean water.

The common practice of human in the world is drinking of water without considering its state or condition. This phenomenon has resulted to a lot of problems because of some pathogens inhabiting in environment or sources of the water while studies have shown that most sources are dumping sites polluted by human and animal activities. So, drinking of polluted or unfit water is a serious issue and another way human health is been endanger. This fact is based on various diseases and life threatening ailments associated with this menace.

In a bid to put an end to this abnormal common practice, production, sales and consumption of packaged water is growing rapidly in the most countries of the world especially the advanced and developed countries most countries of the world [5]. This will go in long way in reducing the havoc caused as a result of consumption of untreated water. The packaged water is water prepared under standard practice and hygienic conditions as required by regulatory authorities, sold to human for their consumption.

The packaged water undergoes several treatment procedures ranging from aeration, addition of chlorine to kill germs and microbes, sedimentation, sand and carbon filters treatment to trapped various size of particles and removal of unwanted odour and subsequent treatment using ultraviolent light and micro-filters before final packaged to the sealed nylons or plastics.

There are has been several reported cases of research work on the microbiological analysis of commercially vended packaged water using different laboratory techniques and reporting different percentages of microbial isolation [6, 7, 8]. This finding is a bad signal to current effort to ensure the availability of clean and pure to mankind. Also, its pose threat to view that treated packaged water will be a pivotal to problems encounter from poor quality of drinkable water today.

With this development, there is a need to channel new front to curb and ensure that there is compliance with standard practice for production of packaged water because diseases and deaths are tremendous public health hazards associated with the consumption of microbial contaminated packaged water [9]. Presently, there are several regulatory bodies across the globe saddled with responsibility of ensuring compliance (standard practice for production of quality drinkable water) with production protocols among the producers and manufacturers. In Nigeria today, National Agency for Food and Drug Administration and Control (NAFDAC) and Standard Organization of Nigeria (SON) are two regulatory bodies mandated to enforce compliance with internationally defined drinking water guidelines.

Despite effort of the two regulatory authorities to ensure compliance, regulation of the packaged water industry aimed at good quality assurance has remained a challenge. To control this menace of contaminated water in sachets, NAFDAC declared a possible 'gradual' nationwide ban on sachet water to allow manufacturers of sachet water to start winding down or change to bottle packaging. Successful implementation of this ban has remained far from reality as the sachet water market is witnessing tremendous growth, especially among the poor and middle social classes. Since scrapping of sachet water cannot be manifested, then there should be continues effort to assess and check the required quality parameters among the vended sachet water, this will serve as measures to check the excesses and level of non-compliance and it will serve as yardstick to penalized manufacturers that found guilty.

The current work is focus on physicochemical and microbiological analysis of selected sachet water vended in Akure, Ondo state, Nigeria. The aim of this study includes, carrying out physic-chemical parameters on selected sachet water and investigating microbiological analysis on selected sachet water.

2. METHODOLOGY

2.1 Sample size and Sample Collection

Five (5) brands of sachet water were sampled in Akure, Ondo State, Nigeria. The samples were collected in clean coolers and transported to the laboratory where they were stored at room temperature until used. The samples include Primus table water; Bofa table water; Zion table water, Aktols table water and Edna table water.

2.2 Physical analysis

i. Test for color

The color of the samples was determined using color test kit (Lovibon comparator, 2000 visual). One tube of the Lovibond comparator matched tube was filled with the water sample to be examined and the other tube was filled with distilled water used as standard control. Both tubes were placed in the comparator, adjusted by rotating the disc until the nearest color match was observed and recorded as Hazen unit [10].

ii. Test for odour

A 20 mL volume of each water sample was poured into a clean beaker. The beaker was then shaken vigorously to check for any frothing and allowed to settle. The beaker was then observed underbright light for presence of any particulate matter and then brought close to the nose to test for any odour present **[**11].

iii. Test for taste

Small volumes of each sample was tasted with the tongue and then immediately rinsed with taste free distilled water after each sample, the result recorded accordingly.

iv. Determination of Temperature

The temperature of all water samples was determined using a simple mercury-in-glass thermometer calibrated in degrees centigrade as described by Edema *et al*., [12] and Dinrifo *et al* ., [10].

v. Determination of Turbidity

Turbidity of all water samples was determined using turbidometer (HANA instrument H193703) expressed in whole number as Nephelometric turbidity unit (NTU) as described by other workers [13, 10, 14].

vi. Total Suspended Solids
The total suspended solids (TSS) content of each water sample was determined with the hach portable colorimeter (Model DR/350) as described by APHA [15]. The instrument was zeroed with 25 ml of deionized water which also served as the blank subsequently the TSS was determined on 25 ml of each water sample after 2 min vigorous shaking.

vii. Determination of pH
The pH of the water samples was determined using a pH meter (Toledo, MP220). Each water sample was measured into 100 cm^3 beaker and the pH determined by inserting the pH meter probe after standardization into the beaker and taking the reading. Standardization of the meter was ensured after each reading [16].

2.3 Chemical analysis

i. Determination of Conductivity
Conductivity of all samples was determined using a digital conductivity meter model 4520 JENWAY, serial No.01263. The meter was switched on and allowed to warm up for about 15 minutes. It was then standardized with 0.01M KCl solution where a conductivity value of 1413 microsiemen per centimeter was obtained; the electrode was thoroughly rinsed with distilled water and then introduced directly into the samples. The value for each sample was taken [17].

ii. Test for Total Hardness
Total hardness of each water sample was determined using a potable UV-visible spectrophotometer (HACH D 89) in which 10 cm^3 of each water sample was pipetted into a sample cell and total hardness reagent H-1K added and allowed to stand for 3 minutes for reaction to take place, after which the total hardness was read [16].

iii. Test for Nitrate and Nitrite
This was done using a potable UV-visible spectrophotometer (HACH D 89). Two cuvettes were filled with 10 cm^3 of the water sample and the content of nitraver 5 nitrate reagent powder pillow was added in one cell, stoppered and shaken vigorously for 1 minute, after which it was allowed to stand for five minutes. An amber color developed if nitrate was present and for nitrite, nitraver 3 reagent powder was added and allowed to stand for 5 minutes, pink colour development is an indication of positive nitrite. Absorbance expressed in mg/l was then measured [16].

iv. 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 [18].
TDS = conductivity×0.6

iv. Test for fluoride
Ten (10) millilitres of each water samples was introduced into dry square sample cell and 2cm^3 of SPADNS reagent was added and swirl to mix. After a minute reaction time the absorbance of the samples was read from the spectrophotometer [16].

vi. 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 Test kits.

2.4 Microbiological Analyses
The microbiological quality of the water samples was determined using total viable count and total coliform count as indices. Total viable count was determined by the pour plate method. Ten fold dilution of the water sample was prepared and 0.1 ml of the dilution was poured on nutrient agar plates and incubated at 37^oC for 24 h. The plates were examined for growth after incubation and developed colonies counted using a digital colony counter (Gallenkamp, England). Total coliform count was determined on each sample by plating presumptive positive samples on Mac Conkay agar. *E.coli* , *Salmonella shigella* and Fungi counts were determined by plating out on Eosin Methylene blue agar, Mannitol Salt Agar and Potato Dextrose Agar respectively. Incubation was done at 35^oC for 48hr.

3.0 RESULT AND DISCUSSION

3.1 Physical parameters analyzed in Sachets table water

Physical parameters tested in all the sachet water samples include; color, odor and taste Table 1. These are important quality parameters affecting acceptability of water for consumption [19]. All the sachet water samples analyzed are clear, colorless, tasteless and unobjectionable. This can be attributed to the use of sand and activated carbon filtration processes used during production in the water factory.

The temperature range of all sachets water analyzed are within the required regulatory standard, while the pH range of 7.3-8.3 (Table 2) were recorded for the sachets water tested, which is within the standard limit of 6.5-8.5 as stipulated by WHO [19] as criteria for drinking water. This also conforms to the pH range reported by other authors [20]. According to Mead *et al*. [21], the pH of most natural waters range from 6.5-8.5 while deviation from the neutral 7.0 is as a result of the carbon dioxide/bicarbonate/carbonate equilibrium. The pH of water is extremely important; fluctuation in optimum pH ranges may lead to an increase or decrease in the toxicity of poisons in water [20].

Total Dissolved Solids of all the sachet water samples is within the standard (500 mg/L) recommended by WHO and NAFDAC. Total dissolved solid is a measure of the level of dissolved solid in water and it influences the taste of drinking water.

All the selected sachets water in Akure have zero total suspended solid (TSS) and zero turbidity (Table 2). Turbidity in water results from the presence of suspended solids therefore the observed zero turbidity is also a reflection of the zero TSS result. Evidently, all the selected sachet water examined in Akure, Ondo state have high standard of clarity indicating that the filtration processes were adequately done during the production process.

Table 1: Physical Analysis (Odour, Colour and Taste) Of Selected Sachet Water Vended in Akure, Ondo State

SAMPLE CODE	ODOUR	COLOUR	TASTE
A	Unobjectionable	Clear	Tasteless
B	Unobjectionable	Clear	Tasteless
C	Unobjectionable	Clear	Tasteless
D	Unobjectionable	Clear	Tasteless
E	Unobjectionable	Clear	Tasteless
STANDARD RANGE	Unobjectionable	Clear	Tasteless

Key: NIS =Nigeria Industrial Standard; A= Primus table water; B= Bofa table water; C= Zion table water, D=Aktols table water and E=Edna table water

Table 2: Physical Properties of Selected Sachets Water Vended in Akure, Ondo State

Sample Code	TEMP (^oC)	pH	TDS (mg/L)	Turbidity(NTU)	TSS (mg/L)
A	25.3	8.1	25	0	0
B	25.5	7.4	32	0	0
C	26.2	7.5	15	0	0
D	25.9	8.3	18	0	0
E	25.4	7.3	12	0	0
NIS (306) LIMIT	25.2-26.6	6.5-8.5	0-500	0-5	0-500

Key: NIS =Nigeria Industrial Standard; TDS= Total dissolved solid; TURB=Turbidity; TSS=Total Suspended Solids; TEMP=Temperature. A= Primus table water; B= Bofa table water; C= Zion table water, D=Aktols table water and E=Edna table water

3.2 Chemical parameters analyzed in Sachets table water

Conductivity value in all the selected sachet water samples analyzed are within the acceptable limit of less than 1000µs/cm stipulated by NIS, 2007 standard Table 3. Similar result was reported in the work of Nwosu *et al*, 2004, in which conductivity below 1000µs/cm was recorded in sachet water samples sold in Owerri metropolis.

Other chemical parameters tested such as chloride, fluoride, free chlorine, nitrate and nitrite are within the acceptable limits of standards Table 3. Heavy metals tested, such as; Manganese (Mn), Zinc (Zn), Copper (Cu), Lead (Pb) and Arsenic (As) in selected sachet water marketed in Akure, Ondo State conformed satisfactorily to the requirements of the WHO, 2004 and NIS, 2007 standards Table 3.

Table 3: Chemical Analysis of Selected Sachet Water Vended in Akure, Ondo State

Sample Code	NIS (306) LIMIT	A	B	C	D	E
Conductivity (29^oC)	0-1000 µs/cm	16	19	12	19	27
Chloride content	0-250 mg/L	0.7	4	8	10	16
Fluoride content	0-15 mg/L	-	-	-	-	-

Iron content	0-0.3 mg/L	0.2	0.2	0.1	0.05	0.1
Nitrate content	0-0.2 mg/L	3.0	5	4	8	6
Nitrite content	0-0.2 mg/L	0.13	0.11	0.14	0.16	0.12
Manganese content	0-0.2 mg/L	0	0	0	0	0
Zinc content	0-3.0 mg/L	0.02	0.11	0.14	0.16	0.21
Hardness	0-150 mg/L	9	8	7	6	12
Copper	0-1.0 mg/L	0	0	0	0	0
Lead	0-0.01mg/L	0	0	0	0	0
Arsenic	0-0.1 mg/L	0	0	0	0	0

Key: NIS =Nigeria Industrial Standard; A= Primus table water; B= Bofa table water; C= Zion table water, D= Aktols table water and E=Edna table water.

3.3 Microbiological analysis of Selected Sachets table water

The results of the microbiological analysis showed that all the brands of water had total plate counts less than 100 cfu/mL maximium limit recommended by World Health Organization and Nigeria Industrial Standard (NIS) Table 4. All the selected sachet water marketed in Akure had total plate count ranging from 1 to 15 cfu/100mL Table 4. This range is permissible for drinking water samples. In addition, all the brands of sachet water analyzed had zero coliform, *E.coli*, Fungi and Salmonella shigella counts.

Table 4: Selected Microbiological Characteristics of Sachet Water Marketed In Akure, Ondo State

Sample Code	Total Plate Count (cfu/ml)	Coliform count (cfu/ml)	*E.coli* (cfu/ml)	Fungi (cfu/ml)	Salmonella shigella (cfu/ml)
A	7	Nil	Nil	Nil	Nil
B	4	Nil	Nil	Nil	Nil
C	1	Nil	Nil	Nil	Nil
D	15	Nil	Nil	Nil	Nil
E	3	Nil	Nil	Nil	Nil
NIS (306) LIMIT	100	Nil	Nil	Nil	Nil

Key: NIS =Nigeria Industrial Standard ,A= Primus table water; B= Bofa table water; C= Zion table water, D=Aktols table water and E=Edna table water

4. CONCLUSION

The findings on selected sachet water quality vended in Akure, Ondo state through physicochemical and microbiological analysis showed that physical parameters such as appearance, color, taste and pH conformed to the acceptable standards as required by regulatory authority. Chemical properties such as conductivity, total hardness, nitrate and nitrite, total dissolved solids, fluoride and heavy metals such as Manganese (Mn), Arsenic (As), Zinc (Zn), Copper (Cu), and lead (Pb) conformed to the requirements of WHO and NIS standards. The report of this work reveals that five sachets water considered for this study conform satisfactorily to regulatory requirement. There is therefore need for NAFDAC to intensify efforts in the routine monitoring of activities in the packaged drinking water industry so as to ascertain level of conformity and their safety for human consumption. It is evident from this study that all selected water samples sold in Akure at the time of the study met recommended standards for Physical, Chemical and microbiological qualities. Since the study conducted using randomly selected sachet water samples produced in Akure, it is advised that further study should be carried out on more sachet water brands in order to ascertain strict compliance with WHO standards. This would help to avert public health hazards associated with the consumption of contaminated sachet water.

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6. REFERENCES

[1] Onilude AA, Adesina FC, Oluboyede OA and Adeyemi BI (2013). Microbiological quality of sachet packaged water vended in three local government of Oyo State, Nigeria. *African Journal of Food Science and Technology* 4: 195-200.

[2] Thliza LA, Khan AU, Dangora DB and Yahaya A (2015). Study of some bacterial load of some brands of sachet water sold in Ahmadu Bello University (Main Campus), Zaria, Nigeria. *International Journal of current Science* 14:91-97.
[3] Anyamene NC and Ojiagu DK (2014) Bacteriological Analysis of sachet water sold in Akwa Metropolis, Nigeria. *International Journal of Agriculture and Biosciences* 3: 120-122.
[4] Isikwue MO and Chikezie A (2014). Quality assessment of various sachet water brands marketed in Bauchi metropolis of Nigeria. *International Journal of Advances in Engineering and Technology* 6: 2489-2495.
[5] Gangil R, Tripachi R, Patyal A, Dutta P and Mathur KN (2013). Bacteriological evaluation of packaged bottled water sold at Jaipur city and its public health significance. *Veterinary World* 6: 27-30.
[6] Prasanna RB and Reddy MS (2009). Bacteriological examination of drinking water with reference to coliforms in Jeedimetia, Hyderabad, India. *African Journal of Biotechnology* 8: 5506-5507.
[7] Kuitcha D, Ndjama J, Tita AM, Lienou G, Kamgang K, Beyala V, Ateba BH and Ekodeck GE (2010). Bacterial contamination of the upper points of the Mfoundi watershed, Yaounde, Cameroon. *African Journal of Microbiological Research* 4: 568-574.
[8] Oludairo OO, Kwaga JKP, Dzikwi AA and Kabir J (2013). The genus *Salmonella*, isolation and occurrence in wildlife. *International Journal of Microbiology and Immunology Research* 1: 47-
[9] Oladapo IC, Oyenike IC and Adebiyi AO (2009). Microbiological analysis of some voided sachet water in Ogbomoso, Nigeria. *African Journal of Food Science* 3: 406-412.
[10] Dinrifo, R. R.; Babalunde, S. O.; Bankole, Y. O. and Demu, Q. A., (2010): Physicochemical properties of rain water collected from some industrial areas of Lagos State, Nigeria. European Journal of Scientific Research 41(3): 383 – 390.
[11] Yakassai, I.A., (2009) Analysis and production of packaged water, Pressma printing and publications, Nigeria, 30-41.
[12] Edema, M. O.; Omemu, A. M. and Fapetu, O. M.(2001): Microbiology and physicochemical analysis of different sources of drinking water in Abeokuta, Nigeria. Nigerian Journal of Microbiology 5: 57 – 61.
[13] Essien, E. B. and Olisah, A. C. (2010): Physicochemical and microbiological quality of water samples in three Niger Delta States, Nigeria. Journal of Pharmacy Research 8(3): 1844 – 1847.
[14] Olaoluwa, O. J.; Olubukola, O. A; Deborah, D. O., Oluwanike, O.; Oluwaloyin, I., and Oladipo, A. (2010): Incidence of drug resistant bacteria and physicochemical properties of Ero Dam, Nigeria. Report and Opinion 2(12): 78
[15] APHA – AWWA, **1998**, *Standard Methods for the Examination of Water and Waste- water, 19thEd.* American Publication Health Association, Washington, pp. 136.
[16] AOAC., (2006): Association of Analytical Chemists, Official Methods of Analysts, 18th Edition.
[17] Bennet, D.P. and David, A.H. (1974): Introduction to Field Biology 2nd Edition, Macmillan Publishing Company, Glasgow, Great Britain p. 25
[18] APHA (1985): Standard Methods for the Examination of Water and Wastewater. 19th edition.
[19] WHO, 1997. WHO Guidelines for Drinking Water Quality. Expert Committee on International Standard for Drinking Water, Geneva 27, Switzerland.
[20] Okonko, I.O., O.D. Adejoye, T.A. Ogunnusi, E.A. Fajobi and O.B. Shittu, 2008. Microbiological andphysicochemical analysis of different water samples used for domestic purposes in Abeokuta and Ojota,Lagos State, Nigeria. Afr. J. Biotechn., 7(3): 617-621.
[21] Mead, A.M., G. Helm, P. Callan and R.M. Atlas, 1999. A prospective study of drinking water quality and gastrointestinal diseases. New Eng. J. Med., 245(9): 224-24.