Quality Assessment of Various Brands of Sachet Water In Uyo

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ABSTRACT

Thirteen brands of sachet water, samples A-M, purchased randomly in Uyo metropolis, were analyzed for colour, odour, taste, turbidity, pH, total dissolved solids and conductivity. Other parameters evaluated included presence and quantity of various cations and anions as well as presence of microbial organisms and their biochemical reactions using standard methods. Eleven of the brands met the World Health Organization (WHO) standard in terms of pH value. All the brands were satisfactory in colour while five brands were defective in both taste and odour. Chemical compounds like cyanide and phenol were found in four and twelve brands respectively. Chemical elements such as selenium, copper, barium, iron, and calcium were found in concentrations above WHO stipulated values in some of the brands. Only two of the brands were devoid of any microbe. The remaining eleven brands had one or more of the following organisms- *Escherichia coli*, *Staphylococcus aureus*, *Staphylococcus albus*, *Bacillus subtilis*, *Madurella myetomi*, *Micrococcus species*, *Aspergillus flavus*, *Rhizopus and Chaetonium*. None of the brands had manufacturing or expiry dates. The results showed that only one of the brands, out of the thirteen brands assayed, that is 7%, passed all the tests and, as such is fit for human consumption without further purification.

KEY WORDS: sachet water, physical , chemical and microbial properties.

INTRODUCTION

Water is a liquid formed by the chemical combination of hydrogen and oxygen in a ratio of 2:1 (Wilson, 1990). It constitutes 60-70% of body weight in men and 55-60% in women (Wilson, 1990; Walker and Edwards, 2005). Seventy percent (70%) of the earth's surface is occupied by water out of which 97% is salt water, leaving 3% as fresh water. Only about 1% of the fresh water is fit for drinking (Answers.com, 2014; Ecoevaluator.com, 2014). Due to the crucial role water plays in the lives of humans, most often, emphasis is placed on its availability with little or no concern on its safety profile. The health of the entire globe depends heavily on the quality of water being consumed. Waterborne diseases have been estimated to cause more than two million deaths and four billion cases of diarrhoea annually (WHO, 2000). Unsafe water is a global public health threat, placing people at risk of a host of water borne diseases such as worm infestations, water blindness, dysentery, diarrhoea, typhoid fever, cholera, gastroenteritis, amoebasis, hepatitis, schistosomiasis, and other diseases (Arizona Department of Health Services, 2012) as well as chemical intoxication (heavy metal poisoning). It is estimated that 2.5 billion people lack access to improved sanitation and about 1.1 billion still defecate in the open (WHO/UNICEF, 2012 ; WHO, 2014).

Due to lack of adequate provision of public clean drinking water supply, our cities and towns have witnessed proliferation of companies providing 'drinking water' in commercially available easy-to-open 500-600 ml polyethylene bags known as sachet water. The sachet water brands are highly patronized. Considering the enormity of the danger which unhygienic and untreated water poses to human lives, it is reasonable and justifiable to intermittently assess available brands of sachet water being hawked for the consumption of the populace. This study was therefore carried out to determine the suitability of the water brands for human consumption.

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METHODS

Materials: Thirteen brands of sachet water were randomly purchased from various hawkers. The samples were certified perfectly sealed before purchase. They were stored in a refrigerator pending analyses. The following information were recorded from the inscriptions on the sachet bags: company name, brand name, location of manufacturer, NAFDAC (National Agency For Food and Drugs Administration and Control) number and volume of water. None of the brands had manufacturing or expiry dates.

Test for colour: A matched Nessler tube (glass) was filled with the water sample to be analyzed to the 50 ml mark. By rotating the disc, the colour of the water was compared with the standards on the disc until similarity was observed.

Test for odour: The water samples were sniffed after they were warmed to room temperature. The intensity of the odour sniffed was graded in the range of 0-5.

Test for taste: Each water sample was tested on both tip and back of the tongue after being warmed to room temperature. The intensity of the taste was graded as with the odour.

Turbidity testing: A 2100P Portable Turbidimeter by Hach USA, was used for the analysis. The prescribed procedure for using the instrument was duly followed for all the samples.

Determination of pH: PHS-30 pH meter was used for the analysis. The two electrodes of the instrument were thoroughly rinsed first with distilled water and then with the sample of water to be measured. The instrument was allowed to stabilize after dipping the electrode into the beaker containing the test solution before the reading was taken.

Determination of total dissolved solids and electrical conductivity of water: The apparatus used for these tests was HACH Sension 5 by Hach USA. The electrode was thoroughly rinsed with both distilled water and sample water respectively before being dipped into the water sample for analysis.

Determination of calcium concentrations: Each water sample (50 ml), was separately pipetted into a conical flask. Sodium hydroxide (3 ml of 0.02N) and four (4) drops of Erichrome black T were added to the water sample in the conical flask.

Ethylene diamine tetra acetic acid (EDTA) was used to titrate against the mixture until a blue colour was formed which signified the end-point. Using the titre values obtained, the calcium concentration of each sample was calculated in mg/L.

Determination of calcium carbonate (total hardness): The determination of calcium carbonate ($CaCO_3$) followed the same procedure as that of calcium except that ammonium chloride (NH_4Cl) was used as buffer instead of sodium hydroxide (NaOH).

Determination of heavy metals, trace elements, cations and anions: These tests were carried out using portable, Dialogging spectrophotometer (HACH DR2010 by Hach USA). The water sample to be analyzed was poured into a glass bottle (previously rinsed with distilled water) in a jacket in the machine. The wavelength associated with the element or radical of interest to be monitored was dialled on the machine to reveal the concentration of that element or radical in the sample of water.

Test for presence of coliforms: The multiple-tube method was used. This entailed presumptive coliform count (Adekunle, 2002) and confirmed tests coliform count (Adekunle, 2002). For the presumptive tests, all inoculated broths were incubated at 37^0C for 24 hours. Similarly, for the confirmation test, the inoculated eosin methylene blue agar plates were incubated at 37^0C for 24 hours.

Pour plate technique: The Pour plate technique enabled the determination of number of colony forming units in the samples per mL (cfu/mL). Two culture media were used: nutrient agar (general purpose medium) and Sabourand dextrose agar (selective medium for isolation of yeast and fungi). Incubation of the inoculated Petri-dishes was done at room temperature for 24-48 hours. All the colonies were counted.

Biochemical tests: Various biochemical tests were carried out to aid the identification and classification of the microbial contents of the nutrient agar plates. The tests included: Gram stain, motility test, coagulase test, catalase production, oxidase test, sugar fermentation, nitrate reduction, indole production, urease test and citrate utilization.

Identification of the organisms on the Sabourand dextrose agar (SDA) plates

Microscopical viewing of the developed inoculated SDA plates helped to identify the fungal organisms present.

RESULTS

The results of physical tests are recorded in table 1. The results of chemical tests are in table 2. Table 3 contains results of Presumptive tests, while Confirmation test results are recorded in table 4. The results of the Pour plate technique experiment are recorded in table 5. Tables 6 and 7 contain results of biochemical tests of the samples using nutrient agar plates and Sabaurand dextrose agar plates respectively. Table 8 reflects the summary of the microbial analyses.

Table 1. Results of the physical tests on the various brands of sachet water

Sample	Colour	Odour	Taste	Turbidity (NTU)*	pH	Total dissolved solids (mg/L)	Conductivity (ms/cm)
A	5	1	1	3.21	7.21	12.60	27.60
B	5	0	0	1.32	7.49	11.60	25.40
C	5	1	1	1.88	7.47	11.80	32.10
D	5	2	2	1.79	7.22	6.60	14.96
E	5	2	2	1.63	7.44	36.40	77.40
F	5	5	5	0.26	7.35	42.10	89.30
G	5	2	2	4.21	7.32	56.10	18.90
H	5	1	1	1.35	7.17	11.70	25..70
I	5	3	3	1.93	5.00	39.70	84.20
J	5	1	1	1.42	7.43	39.90	84.60
K	5	5	5	9.99	6.10	197.30	408.00
L	5	3	3	2.80	7.24	3.70	8.85
M	5	4	3	0.39	7.38	36.40	77.40

*NTU= Nephelometric turbidity unit.

Table 2. Result of chemical tests on the various brands of sachet water in mg/L

Water sample	Calcium	Calcium carbonate	Sulphate	Free residual chlorine	Chloride	Fluoride	Nitrate	Cyanide	Lead	Phenol	Magnesium	Manganese	Arsenic	Barium	Zinc	Selenium	Mercury	Iron	Copper
A	32.0	58.0	3.0	0.1	0.2	0.0	0.005	0.001	0.004	0.007	0.11	0.012	0.01	3.0	0.02	0.02	0.001	0.06	0.06
B	42.0	42.0	2.0	0.1	0.1	0.0	0.010	0.000	0.001	0.000	0.14	0.001	0.00	1.0	0.00	0.01	0.001	0.01	0.04
C	48.0	44.0	5.0	0.1	0.3	0.0	0.020	0.001	0.002	0.006	0.10	0.015	0.00	3.0	0.00	0.03	0.000	0.07	0.08
D	32.0	34.0	2.0	0.1	0.1	0.0	0.010	0.000	0.003	0.005	0.08	0.002	0.00	3.0	0.04	0.02	0.001	0.01	0.07
E	64.0	60.0	1.0	0.1	0.1	0.0	0.000	0.000	0.000	0.002	0.15	0.000	0.00	1.0	0.00	0.00	0.000	0.00	0.01
F	56.0	136.0	1.0	0.1	0.3	0.0	0.010	0.000	0.001	0.003	0.13	0.000	0.00	4.0	0.00	0.06	0.000	0.00	0.03
G	63.4	100.0	4.0	0.1	0.2	0.0	0.010	0.000	0.002	0.006	0.12	0.003	0.00	2.0	0.01	0.02	0.000	0.04	0.03
H	88.0	60.0	2.0	0.1	0.2	0.0	0.030	0.020	0.003	0.000	0.09	0.002	0.00	4.0	0.01	0.04	0.001	0.04	0.04
I	50.0	24.0	1.0	0.1	0.1	0.0	0.020	0.000	0.001	0.003	0.06	0.000	0.00	3.0	0.00	0.01	0.001	0.03	0.03
J	42.0	14.0	2.0	0.1	0.3	0.0	0.020	0.000	0.003	0.006	0.18	0.008	0.00	4.0	0.00	0.03	0.000	0.05	0.05
K	80.0	70.0	8.0	0.1	0.3	0.0	0.070	0.000	0.001	0.005	0.20	0.000	0.00	3.0	0.00	0.03	0.001	0.09	0.02
L	116.0	256.0	2.0	0.1	0.2	0.0	0.010	0.000	0.001	0.003	0.05	0.001	0.00	4.0	0.00	0.01	0.001	0.00	0.03
M	22.0	34.0	6.0	0.1	0.4	0.0	0.050	0.010	0.004	0.011	0.07	0.006	0.00	4.0	0.04	0.06	0.001	0.06	0.04

Table 3. Result of presumptive test for Coliforms

Sample	A	B	C	D	E	F	G	H	I	J	K	L	M
10ml Double strength	0	0	3	3	3	4	2	2	5	1	5	2	2
1ml Single strength	0	0	2	1	2	3	1	1	3	1	5	1	1
0.1ml Single strength	0	0	1	1	1	1	1	0	1	1	4	0	1
NPN	<0.01	<0.01	<0.17	0.14	0.17	0.33	0.09	0.07	0.10	0.06	16	0.07	0.09

Table 4. Result of Confirmatory test for *E. coli*

Sample	A	B	C	D	E	F	G	H	I	J	K	L	M
E. coli	-ve	-ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve

Table 5. Result of pour plate technique experiment

	Nutrient agar plate				Sabourand dextrose agar plate			
	At 24 hours		At 48 hours		At 24 hours		At 48 hours	
Sample	Growth	No of colonies	Growth	No of colonies	Growth	No of Colonies	Growth	No of colonies
A	-ve	-	-ve	-	-ve	-	-ve	-
B	-ve	-	-ve	-	-ve	-	-ve	-
C	-ve	-	+ve	08	-ve	-	+ve	02
D	+ve	15	+ve	30	-ve	-	+ve	01
E	+ve	10	+ve	30	-ve	-	+ve	30
F	+ve	01	+ve	02	-ve	-	-ve	-
G	+ve	01	+ve	08	-ve	-	-ve	-
H	+ve	08	+ve	09	-ve	-	-ve	-
I	+ve	10	+ve	200	-ve	-	-ve	-
J	+ve	09	+ve	68	-ve	-	+ve	01
K	+ve	02	+ve	02	-ve	-	+ve	02
L	+ve	03	+ve	90	-ve	-	+ve	20
M	+ve	02	+ve	06	-ve	-	-ve	-

Table 6. Result of biochemical tests using nutrient agar

Sample	Gram Staining	Motility	Coagulase	Catalase	Oxidase	Maltose	Lactose	Dextrose	Mannitol	Nitrate	Indole	Urease	Citrate	Organism
A	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
B	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
C	+ve	-ve	+ve	+ve	-ve	+ve	+ve	+ve	+ve	+ve	-ve	-ve	-ve	*Staphylococcus aureus*
D	+ve	-ve	+ve	+ve	-ve	+ve	+ve	+ve	+ve	+ve	-ve	-ve	-ve	*Staphylococcus aureus*
E	+ve	-ve	+ve	+ve	-ve	+ve	+ve	+ve	+ve	+ve	-ve	-ve	-ve	*Staphylococcus aureus*
F	+ve	-ve	+ve	+ve	-ve	+ve	+ve	+ve	+ve	+ve	-ve	-ve	-ve	*Staphylococcus aureus*
G	+ve	-ve	-ve	+ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	-ve	-ve	*Staphylococcus albus (epidermis)*
H	+ve	-ve	-ve	+ve	+ve	-ve	+ve	+ve	-ve	-ve	-ve	-ve	-ve	*Micrococcus spp.*
I	+ve	-ve	+ve	+ve	-ve	+ve	+ve	+ve	+ve	+ve	-ve	-ve	-ve	*Staphylococcus aureus*
J	+ve	-ve	+ve	+ve	-ve	+ve	+ve	+ve	+ve	+ve	-ve	-ve	-ve	*Staphylococcus aureus*
K	+ve	-ve	-ve	-ve	+ve	-ve	-ve	+ve	-ve	-ve	-ve	-ve	+ve	*Bacillus subtilis*
L	+ve	-ve	-ve	+ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	-ve	-ve	*Staphylococcus albus (epidermis)*
M	+ve	-ve	-ve	+ve	-ve	-ve	-ve	+ve	-ve	-ve	-ve	-ve	+ve	*Bacillus subtilis*

Table 7. Result of test using Sabaurand dextrose agar plates

Sample	A	B	C	D	E	F	G	H	I	J	K	L	M
Fungus identified	-	-	*Madurella myetomi*	*Aspergillus flavus*	*Rhizopus*	-	-	-	-	*Rhizopus*	*Chaetomium*	*Madurella myetomi*	-

Table 8. Summary of microbial analyses of various brands of sachet water

Sample	*E. Coli*	*S. aureus*	*S. epidermis*	*Mirococcus spps.*	*B. subtilis*	*Madurella myetomi*	*Aspergilius flavus*	*Rhizopus*	*Chaetomium*
A	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
B	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
C	+ve	+ve	-ve	-ve	-ve	+ve	-ve	-ve	-ve
D	+ve	+ve	-ve	-ve	-ve	-ve	+ve	-ve	-ve
E	+ve	+ve	-ve	-ve	-ve	-ve	-ve	+ve	-ve
F	+ve	+ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
G	+ve	-ve	+ve	-ve	-ve	-ve	-ve	-ve	-ve
H	+ve	-ve	-ve	+ve	-ve	-ve	-ve	-ve	-ve
I	+ve	+ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
J	+ve	+ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve
K	+ve	-ve	-ve	-ve	+ve	-ve	-ve	-ve	+ve
L	+ve	-ve	+ve	-ve	-ve	-ve	-ve	-ve	-ve
M	+ve	-ve	-ve	-ve	+ve	-ve	-ve	-ve	-ve

DISCUSSION

The normal pH range of drinking water is 6.5-8.5 (Faust and Aly, 1998). However, samples I and K had pH of 5.00 and 6.10 respectively. Low pH of water could be as a result dissolved carbon dioxide. Water with a low pH can be acidic and corrosive. Acidic water could have high metallic content with sour taste. Samples A,C,H and M contained cyanide. Cyanide could predispose the consumer to nerve damage or thyroid problems (United States EPA, 2008).The major source of cyanide in drinking water is discharge from industrial chemical factories. Chemical fertilizers used in agriculture may also percolate into the ground water used by the plant to make packaged drinking water (Umesh Isalker, 2014,United States EPA, 2008). All the water samples, with the exception of sample B, contained phenol. Phenols affect the odour and taste of water (United States EPA, 2008). Samples H, K and L had calcium concentration above the upper limit of 75mg/L. Only samples B, E, I and L met the standards for selenium. Apart from samples A and C, all the others had normal copper concentration. Only samples B and E met the approved standard for barium. Samples A, C, H, J, K and M failed the test for iron concentration.

Samples A and B were the only samples devoid of microorganisms, but sample A had earlier been shown to contain cyanide. Cyanide being a powerful poison should be absent in packaged water (Umesh Isalker,

2014, EPA, 2008). The rest had one or more organisms as listed in table 8. The organisms revealed included *E. coli*, *Staphylococcus aureus*, *Staphylococcus epidermis*, *Bacillus subtilis*, *Micrococcus species*, *Madurella myetomi*, *Aspergillus flavus* and *Rhizopus*. These organisms are disease-causing and therefore the water samples containing them could not be fit for drinking. Oladipo *et al* (2009) reported isolation of bacteria pathogens from sachet water vended in Ogbomoso, Oyo State, Nigeria. Interestingly, Dada (2009) analysed one hundred samples of sachet water sold in Lagos, Nigeria for bacteriological quality and discovered a 22% non-compliance level. Coliform bacteria were also found in packaged water during a routine exercise of the Food and Drug Administration to check samples of packaged drinking water in India (Imesh Isalker, 2014).

Out of the thirteen water samples analysed in the current study, only sample B could be considered for recommendation, having satisfied all the parameters tested. Therefore, sample B, out of the thirteen, that is 7% of total number of brands assayed, passed the tests, and as such is fit for human consumption.

CONCLUSION

This work endeavoured to ascertain the safety profile of the various brands of sachet water being consumed by the populace in the targeted area. Only one brand out of thirteen (7%) met WHO standard for quality and therefore is fit for drinking. The scenario should be of grave concern to regulatory bodies.

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