

**EVALUATION OF THE PRODUCTION PROCESSES OF DIFFERENT BRANDS OF SACHET WATER SOLD IN THE OPEN MARKET IN ADO-EKITI, SOUTHWEST, NIGERIA**

**Abstract**

*Life on earth is practically impossible without water, in fact, the presence of water on our planet is one of the critical factors that make life possible on earth. Apart from commercial, agricultural, industrial, domestic and sundry uses of water, humans, like other living organisms, require water for their physiological needs. However, as vital as water is to humans, if the water consumed by them is un-potable and unwholesome, it can lead to serious and sometimes life-threatening illnesses. This thus makes it supremely important to periodically assess and monitor the potability and wholesomeness of any form of drinking water particularly the ones presented to the public. In this study, twenty-two different brands of commercial sachet-water sold in the open market in Ado-Ekiti, southwest, Nigeria were consecutively sampled and analysed. The factories where the brands ere manufactured were also visited and served structured self-administered questionnaires that were filled by their respective production managers. Data from the questionnaires were analysed and juxtaposed with the outcome of laboratory investigations with a view to identifying the factors that were responsible for the unwholesomeness of any of the brands. Out of the twenty-two sachet-water brands sampled, none (0%) had physically visible colour; none (0%) had physically perceivable odour; none (0%) had detectable taste. All (100%) were physically clear; 1 (5%) was bagged in a 60-cl cellophane sachet, while 21 (95%) were bagged in 50-cl cellophane sachets; all (100%) claimed to have NAFDAC (the regulatory agency responsible for the control and regulation of food, drugs and allied products in Nigeria) registration number- going by what was written on their finished products. Nearly all- 21 (95%)- all the sampled brands had a pH value of 5, while 1 (5%) had pH value of 6, resulting in a mean pH of 5. More than half of the brands sampled from the open market- 11 (50%)- yielded a*

29 *positive culture result, 3 (14%) of which were coliforms. According to WHO standards there*  
30 *shouldn't be a single coliform bacterium in drinking water, which makes it quite unsettling that*  
31 *three of the brands contained coliforms which of course could be enteric coliform- an indication*  
32 *of the fact that these brands had come in contact with human faeces. The public health*  
33 *implication of this is discussed and appropriate recommendations made.*

34 Keywords: sachet-water, water-production, drinking water, Ado-Ekiti

35

## 36 Introduction

37 Water is an important physiological need of living organisms, including humans.  
38 Just like the planet on which humans live, which has about 71% of its surface  
39 covered by water (USGS, 2019a), water also constitutes about 60% of humans'  
40 total body mass (USGS, 2019b). Apart from drinking purpose, humans also require  
41 water for other sundry purposes, ranging from domestic, agricultural to industrial  
42 uses, among others. However, of all these myriads of uses, none endangers  
43 individual and community health of people like, drinking. In developing nations of  
44 the world- Low-and-middle-income countries (LMICs) in general but sub-Saharan  
45 nations in particular- waterborne diseases like, diarrhoea, dysentery, typhoid,  
46 cholera etc remain major public health challenge (Stoler *et al.*, 2012; Addo *et al.*,  
47 2019). According to the World Health Organisation (WHO), about 80% of diseases  
48 and illnesses in developing countries are directly or indirectly traceable and  
49 attributable to consumption of unwholesome water, arising from non-availability  
50 of potable water (Isa *et al.*, 2013; WHO, 2011; David and Daodu, 2016). In  
51 Nigeria, it's been estimated that about 200, 000 diarrhoea-related deaths are  
52 recorded annually in under-5 children (United Nations, 2012). Also, in Ghana  
53 studies have shown that water-borne diseases, like dysentery, typhoid, some types  
54 of hepatitis, diarrhoea and cholera are very common and rampant among

55 undergraduates at the Kwame Nkurumah University of Science and Technology,  
56 resulting in morbidities and mortalities (WHO, 2010). The vast majority of the 1.1  
57 billion people estimated by WHO as lacking access to quality and safe potable  
58 water are in developing nations, particularly, sub-Saharan Africa (David and  
59 Daodu, 2016)

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61 As in most developing countries, in Nigeria, lack of access by the masses to  
62 potable and wholesome water has pushed lots of people to alternative sources of  
63 water- streams, uncovered water-wells etc- which are prone and open to  
64 contamination. In a nation like Nigeria, where open defecation is rife and  
65 widespread, the wholesomeness of most surface and shallow underground water is  
66 often doubtful. But sadly, these unsafe sources of water are the ones that the  
67 masses generally have access to. Due to its ubiquity and affordability, most people  
68 who lack access to potable public water supply and who do not have the means to  
69 provide safe water sources in their houses, take solace in the ubiquitous sachet-  
70 water, which they see as safe for human consumption (Ackah *et al.*, 2012;  
71 Adewoye *et al.*, 2015)

72 Unfortunately, quite a lot of these brands of sachet-water which the masses  
73 perceive as safe for drinking are unsafe. Several surveys and studies have proven  
74 that most brands of sachet-water are unwholesome and therefore unfit for  
75 drinking, in line with WHO guidelines for drinking water (Onilude *et al.*, 2013;  
76 Oladipo *et al.*, 2009; Edema *et al.*, 2011; Afiukwa *et al.*, 2010; Akpoborie and  
77 Ehwarimo, 2012; David and Daodu, 2016). While several studies have been  
78 carried out by various researchers in Nigeria on the physicochemical and  
79 bacteriological quality of sachet-water brands sold in Nigeria- with their findings  
80 showing that most of the brands are unwholesome- yet, there seems to be paucity  
81 of data in literature on the factors that are responsible for the overwhelmingly

82 reported unwholesomeness of the ubiquitous sachet-water. This study therefore  
83 aimed not only at assessing the wholesomeness or otherwise of the various brands  
84 of sachet-water sold in Ado-Ekiti but also reviewing the production processes of  
85 the factories where the brands are manufactured, with a view to identifying the  
86 factors that are responsible for the unwholesomeness of any one discovered to be  
87 unwholesome

## 88 Methodology

### 89 Study Location

90 The study was carried out in the city of Ado-Ekiti, Ekiti State, one of the thirty-six  
91 states of Nigeria. It's located on latitude  $7^{\circ} 40'$  North of the Equator and Longitude  
92  $5^{\circ} 16'$  East of the Greenwich Meridian. Ado-Ekiti is about 200m above the sea level  
93 in the South but 500m in the North. The landscape is characterized by rounded  
94 inselbergs and steep-sided volcanic hills such as Olot rock. The terrains are gently  
95 undulating. The major rivers in Ado-Ekiti are Amu, Awedele, Ureje and Ogbese.  
96 Going by the 2006 national census conducted by the National Population  
97 Commission, Ado-Ekiti officially has a population of 308,321 (ADO-LEEDS,  
98 2008).

99

### 100 Study Population

101 Twenty-two different brands of commercially-packaged sachet-water- commonly  
102 referred to as 'pure water' in local parlance- were consecutively sampled from the  
103 open market.

104

### 105 Analysis of Physical Features

106 The 22 brands of sachet water were assessed in the laboratory for the following  
107 physical parameters; colour, odour, taste, clarity, volume and evidence of

108 registration with the national regulatory body NAFDAC (National Agency for the  
109 food and drug administration and control)

110

#### 111 Bacteriological analysis

112 The samples were cultured aseptically on chocolate agar and MacConkey agar and  
113 were incubated overnight at 37<sup>0</sup>C. After overnight incubation, the plates were  
114 brought out of the incubator and examined for the presence of bacterial growth  
115 and identification. The bacterial load of the samples that yielded bacterial growth  
116 was determined by multiplying the number of colonies present with the volume of  
117 the wire-loop used for inoculation and the result was expressed as cfu/ml.

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#### 120 Administration of Questionnaire

121 The factories where the samples were manufactured were traced through the  
122 addresses on their finished products. Structured self-administered questionnaires  
123 were served on the production manager of each factory, so as to obtain data on  
124 their production process

#### 125 Results

126 Out of the twenty-two sachet-water brands sampled, none (0%) had physically  
127 visible colour; none (0%) had odour; none (0%) had taste. All (100%) were  
128 physically clear; 1 (5%) was bagged in a 60-cl cellophane sachet, while 21 (95%)  
129 were bagged in 50-cl cellophane sachets; all (100%) claimed to have NAFDAC  
130 number- going by what was written on their finished products (Table 1)

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Table 1: Physical Features

Characteristic	Present	Absent
Colour	0	22
Odour	0	22
Taste	0	22
Clarity	Hazy/Turbid 0	Clear 22
Volume/sachet	50cl 21	60cl 1
NAFDAC Number	Absent 0	Present 22

134

135 Four (18.2%) of the brands sourced their water from the well, 1 (4.5%) from  
 136 natural spring, 17 (77.3%) from bore-hole, while none (0%) sourced water from  
 137 the river or rain (Table 2)

Table 2: Source of Water

Well	4
River/Stream	0
Spring	1
Bore-Hole	17
Rain	0
Total	22

138

139 None (0%) of the brands sourced water from a depth that's less than 10ft, 3 (14%)  
 140 sourced from a depth of 11-15ft, 7 (31%) from 16-20ft, 3 (14%) from  $\geq 20$ ft, while  
 141 9 (41%) did not disclose the depth from which they sourced their water (Table 3)

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Table 3: Depth of source of water

$\leq 10$ ft	0
11-15ft	3
16-20ft	7
$\geq 20$ ft	3
Undisclosed	9
Total	22

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145 Nineteen (86.4%) of the brands treated their water through chlorination, 1 (4.5%)  
 146 used filters, 1 (4.5%) used combination of filtration and chlorination, while 1  
 147 (4.5%) declined disclosure of its water treatment method (Table 4)

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Table 4: Water Treatment Method

Lime/Alum	0
Chlorination	19
Heat	0
Use of filter	1
UV light/ozonisation	0
Chlorination and filter	1
Undisclosed	1
Total	22

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149 Also, 19 (86.4%) do not have a potential source of pollution within 150m radius of  
 150 of their water source, 1 (4.5%) have a potential source of pollution, while 2  
 151 (9.1%) stated that a source of pollution was not close to their source of water  
 152 (Table 5)

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 Table 5: Proximity of Water source to potential pollution

Very close	1
Close	0
Not close	2
None within 150m radius	19

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154 Six (27.27%) bag their sachet water manually, 13 (59%) bagged through  
 155 automation, 1 (4.5%) use semi-automation, while 2 (9.1%) did not disclose how  
 156 they bag their product (Table 6)

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 Table 6: Sacheting Method

Manual	6
Automation	13
Semi-automation	1
Undisclosed	2
Total	22

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160 At all the factories (100%) of the brands, workers practice hand-washing during  
 161 production process; 7 (32%) use face-mask, while 15 (68%) do not use face-mask;  
 162 20 (90.9%) carry out pre-production quality control, while 2 (9.01%) did not  
 163 disclose if they carry out pre-production quality control or not; 19 (86%) carry out  
 164 post-production quality control, while 3 (14%) did not disclose if they carry out  
 165 post-production quality control or not (Table 7)

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 Table 7: Routine Activities
 

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Activity	No	Yes	undisclosed
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Hands washed before and at intervals during production	0	22	
Use of face-mask	7	15	
Pre-production quality control of raw materials	0	20	2
Post-production quality control of finished products	0	19	3
Lab coat	3	19	

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168 Sixteen (73%) have production managers who have degree or a certificate in  
 169 microbiology or food science, 2 (9%) do not have, 2 (9%) have production  
 170 managers who have degree in disciplines other than microbiology or food science,  
 171 2 (%) did not disclose if they have production managers; 18 (82%) have well-  
 172 ventilated factories, while 4 (18%) do not have well-ventilated factories (Table 8)

Table 8: Personnel and Basic Infrastructure

	No	Yes	Diff course	Un
In-house production manager	2	16	2	2
Titled factory floors	1	20		1

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Well plastered and white-painted wall	0	22
POP/PVC ceiling	0	
Ventilation	4	

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174 Nearly all- 21 (95%)- all the sampled brands had a pH value of 5, while 1 (5%)  
 175 had pH value of 6, resulting in a mean pH of 5. Half of the brands 11 (50%)-  
 176 yielded a positive culture result, 3 (14%) of which were coliforms.

Table 9: Culture result

Sample code	Result	Coliform Count
SW001	Coliform	$>4 \times 10^3$ cfu/ml
SW002	Non-coliform	400cfu/ml
SW003	NBG	
SW004	Non-coliform	$>4 \times 10^3$ cfu/ml
SW005	NBG	
SW 006	NBG	
SW007	Non-coliform	$4 \times 10^3$ cfu/ml
SW008	Non-coliform	$4 \times 10^3$ cfu/ml
SW009	NBG	$4 \times 10^3$ cfu/ml
SW010	NBG	
SW011	NBG	

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SW012	NBG	
SW013	Coliform	4 x 10 <sup>3</sup> cfu/ml
SW014	Non-coliform	4 x 10 <sup>3</sup> cfu/ml
SW015	NBG	
SW016	Non-coliform	80 cfu/ml
SW017	NBG	
SW018	NBG	
SW019	NBG	
SW020	Coliform	40 cfu/ml
SW021	Non-coliform	800 cfu/ml
SW022	Non-coliform	4 x 10 <sup>3</sup> cfu/ml

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180 NBG: No bacterial growth

## 181 Discussion

182 Since an overwhelming majority of Nigerians do not have access to potable and  
 183 safe water (Dada, 2009, Ajayi *et al.*, 2008), they rely on commercially-packaged  
 184 drinking water, in forms of sachet ('pure water') or bottled water, especially when  
 185 they are outside their homes. The quality of these commercially-packaged water,  
 186 especially sachet water, has been of concern to lots of researchers, health-  
 187 practitioners and health policy-makers. Though, the commercial sachets of water  
 188 are readily accessible and easily affordable to Nigerians, studies upon studies have  
 189 shown that the concerns that have been expressed about their quality and safety  
 190 have actually not been misplaced (Dufor *et al.*, 2003). Quite a number of these  
 191 commercial brands of sachet water are produced in overtly unhygienic

192 environment, in fact, it has been claimed that some outbreaks of water-borne  
193 diseases are traceable to some brands of these so-called ‘pure water’ (Ugochukwu  
194 *et al.*, 2015). The findings of this study have also confirmed the concerns that  
195 many workers have expressed about the safety of some of these commercially-  
196 packaged water.

197 In this present study, none of the brands of commercial sachet water sampled  
198 consecutively from the open market had visible colour, perceivable odour or  
199 detectable taste or turbidity. This is similar to the findings of Ugochukwu *et al.*,  
200 (2015), who conducted similar study on 16 brands of sachet water sold in Samaru-  
201 Zaria. Also like this study, they reported that all the brands that they sampled had  
202 NAFDAC registration number.

203 In their study of commercially- branded sachet water in Ogbomosho, Oyo state,  
204 Oladipupo *et al* (2009) also recorded growth of coliform in some of the tested  
205 brands. This is in tandem with the findings of this present study, which recorded  
206 50% of the tested brands yielding bacterial growth out of which 14% were  
207 coliform(though this present study was not able to carry out further investigations  
208 to confirm if the coliforms encountered were fecal coliforms).

209 This present study also discovered that a percentage of the surveyed brands of  
210 sachet water sourced their water from water-well, which may not be securely  
211 covered. Quite a significant proportion of the water brands surveyed in this study,  
212 packaged their water manually, this may partially explain the relatively high  
213 number of the brands that have bacterial growth.

#### 214 Conclusion and Recommendation

215 The outcome of this study has shown that some of the brands of commercial sachet  
216 water sold in the market in Ado Ekiti may actually be unsafe and therefore unfit for  
217 human consumption. It is therefore suggested that the appropriate regulatory  
218 agencies and ministries (NAFDAC and Ministry of Environment, in particular)

219 should conduct unscheduled periodic visits to these water factories to review their  
220 production processes and premises with a view forestalling the sale of  
221 unwholesome products to innocent and unsuspecting members of the public.

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## 223 References

224 Adewoye, A. O., Adewoye, S. O. and Opasola, O. A (2015): Microbiological  
225 examination of sachet water experimentally exposed to sunlight. *International*  
226 *Journal of Pure and Applied Sciences and Technology* 18 (1), 36–42

227

228 Ado-LEEDS (2008): Ado-Ekiti Local Economic Empowerment and Development  
229 Strategy

230

231 Addo B. E , Amankwaa G and Gyasi R. M (2019): Physicochemical and  
232 bacteriological quality of sachet water used by Ghanaian university students:  
233 implications for public health. *Journal of water, sanitation and hygiene for*  
234 *development*, 9 (1) 56-63

235 Afiukwa, N.F., Iroha, I.R., Afiukwa, C.A., Ayogu, T.E., Onwa, N.C. and Nwuzo,  
236 A.C. (2010): Presence of antibiotic resistant coliforms in sachet water sold in some  
237 parts of South Eastern Nigeria. *Journal of Microbiology and Antimicrobials*, 2(5).

238 51-54.

239

240 Ajayi A. A, Sridhar M. R, Adekunle, L. V and Oluwande P. A (2008); Quality of  
241 packed water sold in Ibadan, Nigeria. *Afr J Biomed Res*, 11, 251-258

242

- 243 Akpoborie, I.A. and Ehwarimo, A. (2012): “Quality of packaged drinking water  
244 produced in Warri Metropolis and potential implications for public health”.  
245 *Journal of Environmental Chemistry and Ecotoxicology*, 4(11). 195-202.  
246
- 247 Dada A. C (2009): Sachet water phenomenon in Nigeria: Assessment the potential  
248 health impact. *Afr J Microbiol Res* 3, 15-21  
249
- 250 Dufor A, Snozzi M, Koster W, Bartram J, Ronchi E and Fawtrel L (2003):  
251 Assessing Microbial safety of drinking water, improving approaches and methods,  
252 WHO/OECD, p 11
- 253 Edema, M.O., Atayese, A.O. and Bankole, M.O. (2011): “Pure water syndrome:  
254 Bacteriological quality of Sachet-packed drinking water sold in Nigeria”. *African*  
255 *Journal of Food, Agriculture, Nutrition and Development*, 11(1). 4595-4609.  
256
- 257 Daniel E. O and Daodu A. A (2016): Bacteriological analysis of sachet water  
258 vended in Ugbor, Benin City, Nigeria. *SAU Science and Technology Journal*, 1 (1)  
259 88-99  
260
- 261 Oladipo, I.C., Onyenika, I.C. and Adebisi, A.O. (2009): “Microbial analysis of  
262 some vended sachet water in Ogbomoso, Nigeria”. *African Journal of Food*  
263 *Science*, 3(12): 406-412.  
264
- 265 Onilude, A.A, Adesina, F.C , Oluboyede, O.A and Adeyemi, B.I (2013):  
266 Microbiological quality of sachet packaged water vended in three local

267 governments of Oyo State, Nigeria. *African Journal of Food Science and*  
268 *Technology* (ISSN: 2141-5455) 4(9): 195-200.

269

270 Stoler, J. (2012). Spatial Patterns of Water in security in a Developing City:  
271 Lessons from Accra, Ghana. PhD Dissertation, San Diego State University and  
272 University of California, Santa Barbara

273

274 Ugochukwu S, Giwa F. J and Giwa A (2015): Bacteriological evaluation of  
275 sampled sachet water sold in Samaru-Zaria, Nigeria. *Niger J Basic Clin Sci*, 12, 6-  
276 12

277

278

279 United Nations. (2012). The Millennium Development Goals Report 2012 - We  
280 Can End Poverty 2015. United Nations, New York

281

282 USGS (2019a): How much water is there on earth? Available at:  
283 [https://www.usgs.gov/special-topic/water-science-school/science/how-much-](https://www.usgs.gov/special-topic/water-science-school/science/how-much-water-there-earth?qt-science_center_objects=0#qt-science_center_objects)  
284 [water-there-earth?qt-science\\_center\\_objects=0#qt-science\\_center\\_objects](https://www.usgs.gov/special-topic/water-science-school/science/how-much-water-there-earth?qt-science_center_objects=0#qt-science_center_objects). Last  
285 accessed on 14.10.2019

286

287 USGS (2019b): Water in You: Water and Human Body. Available at:  
288 [https://www.usgs.gov/special-topic/water-science-school/science/water-you-water-](https://www.usgs.gov/special-topic/water-science-school/science/water-you-water-and-human-body?qt-science_center_objects=0#qt-science_center_objects)  
289 [and-human-body?qt-science\\_center\\_objects=0#qt-science\\_center\\_objects](https://www.usgs.gov/special-topic/water-science-school/science/water-you-water-and-human-body?qt-science_center_objects=0#qt-science_center_objects). Last  
290 accessed on 14.10.2019

291