



## Evaluation of the Production Processes of Different Brands of Sachet Water Sold in the Open Market in Ado-Ekiti, Southwest, Nigeria

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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### **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

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their physiological needs. However, as vital as water is to humans, if the water consumed by them is not potable or is unwholesome, it can lead to serious and sometimes life-threatening illnesses. This thus makes it 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 were 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 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 positive culture result, 3 (14%) of which were coliforms. According to WHO standards there shouldn't be a single coliform bacterium in drinking water, which makes it quite unsettling that three of the brands contained coliforms which of course could be enteric coliform- an indication of the fact that these brands had come in contact with human faeces. The public health implication of this is discussed and appropriate recommendations made.

*Keywords: Sachet-water; water-production; drinking water; Ado-Ekiti.*

## 1. INTRODUCTION

Water is an important physiological need of living organisms, including humans. Just like the planet on which humans live, that has about 71% of its surface covered by water [1], water also constitutes about 60% of humans' total body mass [2]. Apart from drinking purpose, humans also require water for other sundry purposes, ranging from domestic, agricultural to industrial uses, among others. However, of all these myriads of uses, none endangers individual and community health of people like drinking. In developing nations of the world- Low-and-middle-income countries (LMICs) in general but sub-Saharan Africa in particular- waterborne diseases like, diarrhoea, dysentery, typhoid, cholera etc remain major public health challenge [3,4]. According to the World Health Organisation (WHO), about 80% of diseases and illnesses in developing countries are directly or indirectly traceable and attributable to consumption of unwholesome water, arising from non-availability of potable water (Isa et al., 2013; WHO, 2011), [5]. In Nigeria, it's been estimated that about 200, 000 diarrhoea-related deaths are recorded annually among under-5 children [6]. Also, in Ghana studies have shown that water-borne diseases, like dysentery, typhoid, some types of hepatitis, diarrhoea and cholera are very

common and rampant among undergraduates at the Kwame Nkurumah University of Science and Technology, resulting in morbidities and mortalities (WHO, 2010). The vast majority of the 1.1 billion people estimated by WHO as lacking access to quality and safe potable water are in developing nations, particularly, sub-Saharan Africa [5].

As in most developing countries, in Nigeria, lack of access by the masses to potable and wholesome water has pushed lots of people to alternative sources of water- streams, uncovered water-wells etc-prone and open to contamination. In a nation like Nigeria, where open defecation is rife and widespread, the wholesomeness of most surface and shallow underground water is often doubtful. And sadly, these unsafe sources of water are the ones that the masses generally have access to. Due to its ubiquity and affordability, most people who lack access to potable public water supply and who do not have the means to provide safe water sources in their houses, take solace in the ubiquitous sachet-water, which they see as safe for human consumption [7], (Ackah et al., 2012).

Unfortunately, quite a lot of these brands of sachet-water which the masses perceive as safe for drinking are unsafe. Several surveys and studies have proven that most brands of sachet-

water are unwholesome and therefore unfit for drinking, in line with WHO guidelines for drinking water [8,9,10,11,12,5]. While several studies have been carried out by various researchers in Nigeria on the physicochemical and bacteriological quality of sachet-water brands sold in Nigeria- with their findings showing that most of the brands are unwholesome- yet, there seems to be paucity of data in literature on the factors that are responsible for the overwhelmingly reported unwholesomeness of the ubiquitous sachet-water. This study therefore aimed not only at assessing the wholesomeness or otherwise of the various brands of sachet-water sold in Ado-Ekiti but also reviewing the production processes of the factories where the brands are manufactured, with a view to identifying the factors that are responsible for the unwholesomeness of any one discovered to be unwholesome.

## 2. METHODOLOGY

### 2.1 Study Location

The study was carried out in the city of Ado-Ekiti, Ekiti State, one of the thirty-six states of Nigeria. It's located on latitude 7°40' North of the Equator and Longitude 5°16' East of the Greenwich Meridian. Ado-Ekiti is about 200 m above the sea level in the South but 500 m in the North. The landscape is characterized by rounded inselbergs and steep-sided volcanic hills such as Olota rock. The terrains are gently undulating. The major rivers in Ado-Ekiti are Amu, Awedele, Ureje and Ogbese. Going by the 2006 national census conducted by the National Population Commission, Ado-Ekiti officially has a population of 308,321 [13].

### 2.2 Study Population

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

### 2.3 Analysis of Physical Features

The 22 brands of sachet water were assessed in the laboratory for the following physical parameters; colour, odour, taste, clarity, volume and evidence of registration with the national regulatory body NAFDAC (National Agency for food and drug administration and control).

## 2.4 Bacteriological Analysis

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

## 2.5 Administration of Questionnaire

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

## 3. RESULTS

Out of the twenty-two sachet-water brands sampled, none (0%) had physically visible colour; none (0%) had odour; none (0%) had 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 number-going by what was written on their finished products (Table 1).

**Table 1. Physical features**

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

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

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

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

**Table 2. Source of water**

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

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

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

**Table 3. Depth of source of water**

≤10ft	0
11-15ft	3
16-20ft	7
≥20ft	3
Undisclosed	9
Total	22

**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

**Table 5. Proximity of Water source to potential pollution**

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

At all the factories (100%) of the brands, workers practice hand-washing during production process; 7 (32%) use face-mask, while 15 (68%) do not use face-mask; 20 (90.9%) carry out pre-

production quality control, while 2 (9.01%) did not disclose if they carry out pre-production quality control or not; 19 (86%) carry out post-production quality control, while 3 (14%) did not disclose if they carry out post-production quality control or not (Table 7).

**Table 6. Sacheting Method**

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

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

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. Half of the brands 11 (50%)- yielded a positive culture result, 3 (14%) of which were coliforms.

#### 4. DISCUSSION

Since an overwhelming majority of Nigerians do not have access to potable and safe water [14,15], they rely on commercially-packaged drinking water, in forms of sachet ('pure water') or bottled water, especially when they are outside their homes. The quality of these commercially-packaged water, especially sachet water, has been of concern to lots of researchers, health- practitioners and health policy-makers. Though, the commercial sachets of water are readily accessible and easily affordable to Nigerians, studies upon studies have shown that the concerns that have been expressed about their quality and safety have actually not been misplaced [16]. Quite a number of these commercial brands of sachet water are produced in overtly unhygienic environment, in fact, it has been claimed that some outbreaks of water-borne diseases are traceable to some brands of these so-called 'pure water' [17]. The findings of this study have also confirmed the concerns that many workers have expressed about the safety of some of these commercially-packaged water.

**Table 7. Routine activities**

Activity	No	Yes	undisclosed
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	

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

**Table 9. Culture result**

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

NBG: No bacterial growth

In this present study, none of the brands of commercial sachet water sampled consecutively from the open market had visible colour, perceivable odour or detectable taste or turbidity. This is similar to the findings of Ugochukwu et al., [17], who conducted similar study on 16 brands of sachet water sold in Samaru-Zaria. Also like this study, they reported that all the brands that they sampled had NAFDAC registration number.

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

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

## 5. CONCLUSION AND RECOMMENDATION

The outcome of this study has shown that some of the brands of commercial sachet water sold in the market in Ado Ekiti may actually be unsafe and therefore unfit for human consumption. It is therefore suggested that the appropriate regulatory agencies and ministries (NAFDAC and Ministry of Environment, in particular) should conduct unscheduled periodic visits to these water factories to review their production processes and premises with a view to forestalling the sale of unwholesome products to innocent and unsuspecting members of the public.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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