

# Bacteriological evaluation of commercially packaged sachet water commonly sold in Dutse metropolis, Jigawa State, Nigeria

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Received 29th October, 2020<sup>1</sup>; 16th December, 2020

**ABSTRACT:** Water is a vital gift of nature and elixir to life but population growth has outpaced local effort to satisfy its potable services hence taken over by private sector sale in packaged plastic sachets. The need to ascertain the microbiological quality in order to determine the safety becomes paramount. Ten (10) different brands of sachet water were collected at random at each of the ten visits (n=100) in Dutse metropolis in wet season and then in dry season, making a total of 200 of sachet water samples (n=200). They were analyzed for bacterial loads including aerobic mesophilic and total coliform count, detection of selected bacteria of medical importance such as *Escherichia coli* (O157:H7 inclusive), *Salmonella* sp and *Vibrio cholera* using appropriate media. Results obtained showed that all the water samples met the zero criterion for the presence of coliforms as recommended by WHO and other related bodies. No growth was observed on any of the inoculated plates, indicating absence of any of the target bacteria, portraying good manufacturing practices by the producers and as well indicated high level of conformity to specified standard procedures in treatment, packaging, storage and distribution of sachet waters in the metropolis. These might lead to significant decrease in waterborne illnesses in Dutse metropolitan. It is highly recommended that the producers should keep the feat in order to promote safe public health in this environment.

**Keywords:** Bacteria, coliforms, Dutse, microbiological safety, sachet water.

## INTRODUCTION

Water is the elixir of life which is a precious gift of nature and vital for the survival of mankind most especially when it is safe and to millions of other species living on the earth (Thliza et al., 2015; Bukar et al., 2015; Li and Wu, 2019). Water is known as part of human nutrition which is essential for personal hygiene, production of food and disease prevention thereby improving quality living (Adegoke et al., 2012; Badr and Ruma, 2015). Sachet-packaged water usually referred to as 'pure' water is very common in Nigeria and many developing countries and is sold almost everywhere including streets, schools, highways, market places, restaurants and so on. It has become a primary drinking source for the majority in many

urban areas and countries and also the rate of sale is alarming as both the rich and poor have become patronizers (Stoler, 2017) hence the need to ascertain the quality in order to safeguard the consumer's health. Microbiological quality of drinking water is a concern worldwide because of its public health impacts and it remains the most aspect of drinking water in relation to water borne diseases (Olaoye and Onilude, 2009).

Safe drinking water is one of the oldest public health concerns known as far back as in the ancient civilizations when water treatment such as sand filtration method was employed in Egypt and much later chlorination method. It was reported that the incidence of waterborne disease

dramatically decreased. Safe drinking water is inadequate and the inability of government to provide enough has led to small scale water producing industries packaging and marketing factory filled sachet water (Thliza et al., 2015). The susceptibility of packaged water to microbial, toxic organic and inorganic contamination suggest that sachet water could be a route of transmission for enteric pathogens, challenging its purity and health of consumers (Anyamene and Ojiagu, 2014; Isikwue and Chikezie, 2014). In most developing countries, water quality has become a crucial and urgent problem and matter of concern to both families and communities (Maduka et al., 2014).

Reports have shown that packaged water are not completely free from microbial contaminations, few of these reports include that of Boltaganga municipality, Ghana, 14 (70%) out of 20 sachet water tested had heterotrophic bacteria (101-158 cfu/ml) including *E. coli* and Streptococci (Adetunde et al., 2014). In Zaria, Kaduna State, Nigeria, Thliza et al. (2015) reported that out of 720 from 6 different brands of sachet water, 54 species of bacteria were isolated including *S. aureus* and *E. coli*. *Bacillus* spp and *S. aureus* were predominant. Microbial contamination of packaged water accounts for 80% of illnesses in developing world which threatens public health globally, causing diseases such as cholera, typhoid fever, hepatitis, diarrhoea and others (Ackah-Arthur et al., 2012; Anyamene and Ojiagu, 2014). WHO (2004) estimated that 88% of diarrhoea cases is caused by unsafe water and mortalities associated with diseases and symptoms has exceeded 5 million people annually (Cabral, 2010). Death of more than 1.5 million children each year from diarrhoea due to unsafe water, inadequate sanitation, or insufficient hygiene and more than 1 in 4 deaths of children under 5 years of age are attributable to unhealthy environments and poor immune system (Ibrahim et al., 2015).

Bacteriological quality of drinking water is primarily determined by using "indicator organisms" whose presence indicates faecal contamination (Dunling and Fiessel, 2008) and greater risk of contracting disease when these indicator bacteria are present at higher levels (Alonso et al., 1996). Coliforms especially *E. coli* is recommended indicator. The most dangerous water pollutants are pathogenic microorganisms including *Salmonella* sp, *Shigella* sp, *Vibrio cholerae* and *E. coli*. Naturally occurring opportunistic pathogens commonly found in water include *Pseudomonas aeruginosa*, *Klebsiella* sp, *Aeromonas* sp and might cause diseases in human mostly the debilitated and immunocompromised (Cunningham, 2005; Adamu et al., 2016).

The need for safe and better health cannot be compromised with increasing urbanization and population growth in Dutse and other parts of Jigawa state. (Fenwick, 2006; WHO, 2008). This research is aimed at determining the microbiological and physicochemical quality of commercially packaged sachet water in Dutse metropolis Jigawa state.

## MATERIALS AND METHODS

### Study area

Dutse is a city located in Northwestern Nigeria and the capital of Jigawa State. It has an estimate population of 153,000 according to the record of World Gazette (2007) with geographical coordinates: latitude 11° 42' 04" N and longitude 9° 20' 31"E.

### Collection of samples

Ten (10) different brands of sachet-packed drinking water named using pseudonyms (Addo et al., 2019) commonly sold in Dutse metropolitan were collected at random from vendors for the period of rainy season in the months of August and October 2017 and also during dry season, within January and March 2018. The different brands of sachet water commonly sold in Dutse were purchased from different shops in a visit, making a total of 100 samples considered during the first period of study and another 100 samples of same brands were collected during the second period, giving a total of 200 sachet water of ten different brands considered in the entire study.

### Microbiological analyses of the water samples

#### Physical identification of water samples

**Test for odour:** Fifty milliliters (50 ml) wide mouthed glass-stoppered bottles was rinsed with 4M Hydrochloric Acid (HCl) and then with distilled water. The bottles were half-filled with each sample stoppered and were shaken vigorously for 2 to 3 seconds. The stoppers were then removed and observed for odour using the nostril (Mbaeyi-Nwaoha et al., 2012).

**Test for taste:** A clean sterile spatula was used to take an aliquot (1 ml) of each sample and then the taste was noted immediately (Mbaeyi-Nwaoha et al., 2012).

**Test for colour:** each water sample was poured into clean grease free beaker and was viewed using a bench-top multipurpose photometer (Mbaeyi-Nwaoha et al., 2012).

#### Bacteriological analyses

The analyses included aerobic mesophilic count (AMC), total coliform count (TCC), isolation of selected waterborne bacteria including *E. coli* (O157:H7 inclusive), *Salmonella* spp, and *Vibrio cholerae*.

**Enumeration of bacteria:** 1 ml aliquot of each water sample was aseptically inoculated on each of the sterilized agar (Plate count agar for AMC and MacConkey agar

**Table 1.** Physical/organoleptic analyses of sachet waters for both wet and dry seasons

Brand	Colour	Taste	Odour	Particles	Sealing	NAFDAC No.
ADG	–	–	–	Nil	Good	+
DDB	–	–	–	Nil	Good	+
DAG	–	–	–	Nil	Good	+
HAH	–	–	–	Nil	Good	+
IUA	–	–	–	Nil	Good	+
LAU	–	–	–	Nil	Good	+
MAU	–	–	–	Nil	Good	+
ABM	–	–	–	Nil	Good	–
SBO	–	–	–	Nil	Good	+
SHM	–	–	–	Nil	Good	+

+ = present; - = absent.

**Table 2.** Mean Aerobic Microbial Loads of the Sachet Waters during the Period of Study (x 10cfu/ml).

Brand	AMC		TCC	
	Wet season	Dry season	Wet season	Dry season
ADG	1.0	2.0	0.0	0.0
DDB	0.0	5.1	0.0	0.0
DAG	0.2	0.0	0.0	0.0
HAH	0.0	3.3	0.0	0.0
IUA	0.0	0.4	0.0	0.0
LAU	0.0	1.1	0.0	0.0
MAU	2.1	3.2	0.0	0.0
ABM	0.0	3.0	0.0	0.0
SBO	0.0	0.1	0.0	0.0
SHM	0.0	0.0	0.0	0.0

[OXOID™, England] for TCC) using pour plate method. They were produced in duplicate and incubated at 37°C for 24 hours. The plates were carefully observed for microbial growth and distinct colonies enumerated, and expressed in CFU/mL.

**Isolation of bacteria:** 1 ml of aliquot of each water sample was inoculated onto eosine methylene blue, sorbitol macConkey, salmonella-shigella, MacConkey [OXOID™, England] using pour plate method for the detection of *E. coli*, *E. coli* O157:H7, *Salmonella sp.*, and *Vibrio cholerae* respectively (Tiwari et al., 2009; Cheesbrough, 2010). They were produced in duplicate after which they were incubated at 37°C for not less than 24 hours. The plates were carefully observed for microbial growth. Microscopy and appropriate biochemical tests including indole, Voges Proskauer, methyl red, indole and citrate (Cheesbrough, 2010) were used for the detection of enteric bacteria (coliforms).

## RESULTS

Table 1 summarizes the physical/organoleptic characteris-

tics of the water samples for both seasons. The results showed absence of colour, taste, and odour in the samples. All except one of the sachet waters had NAFDAC number. Sealing of all the sachet water was satisfactory, no any leakage was observed. More so, they were all free of particles.

Results obtained for AMCs as shown in Table 2 indicated few growths observed within the range of 0.0 x 10 and 6.0 x 10 CFU/mL with exception of SHM that had none. However, the AMC obtained were more frequent in dry than rainy season. The TCCs of the water samples were shown to have zero results (0.0CFU/mL) as obtained for both seasons.

In Table 3, none of the targeted bacteria was isolated. No growth was observed on any of the culture plates after incubation.

## DISCUSSION

The absence of colour, taste, odour and particles in the samples were similarly obtained by Akinsola et al. (2020). This is in line with the standard of WHO and NAFDAC and

**Table 3.** Isolation of selected waterborne bacteria from the sachet water samples.

Brand	<i>E. coli</i>	<i>Salmonella spp</i>	<i>Vibrio cholerae</i>	Status
ADG	-	-	-	Satisfactory
DDB	-	-	-	Satisfactory
DAG	-	-	-	Satisfactory
HAH	-	-	-	Satisfactory
IUA	-	-	-	Satisfactory
LAU	-	-	-	Satisfactory
MAU	-	-	-	Satisfactory
ABM	-	-	-	Satisfactory
SBO	-	-	-	Satisfactory
SHM	-	-	-	Satisfactory

could be attributed to good manufacturing practices (Mbaeyi-Nwaoha et al., 2012). All except one of the sachet waters had NAFDAC number as also observed by Airaodion et al. (2019). This might have guaranteed an expected level of monitoring of production by NAFDAC. Sealing of all the sachet water was satisfactory because no any leakage was observed. This could be a confirmation of good practice of proper packaging in all the factories responsible for production of these sachet waters.

The AMC and zero TCC results obtained are in agreement with the results obtained by some researchers (Ndinwa et al., 2012; Ojo, 2015; Airaodion et al., 2019) and met the required standard limits of WHO (2008) ( $\leq 100$  for AMC and 0.00 for TCC) and those of National Agency for Food and Drugs Administration and Control (NAFDAC). As a result, the water samples could be said to be of good microbiological quality and satisfactorily fit for consumption. However, this is not in conformity with  $> 0$  cfu/ml total coliform counts obtained by Yousaf and Chaudry (2013) in Pakistan, Ibrahim et al. (2015) in Bauchi, Addo et al. (2019) in Ghana, Li and Wu (2019), and Solana et al. (2020) in Aiyetoro, Ogun state. These results might be tied to good manufacturing practices employed by the producers and the sources of water mostly bore hole. Poor industrial setting and lack of any main river present in Dutse metropolis due to low level of rainfall could have contributed to very few counts and zero results obtained. This might lead to a significant decrease in waterborne illnesses in the area of study thereby, improving the public health standard. The TCC results obtained in both seasons (Table 3) shows zero coliform.

None of the target organisms was found in this study. This is a rare result but in agreement with results obtained in similar research work conducted by Enwere and Ade (2006). However, it was not in agreement with those of Oluwafemi and Oluwole (2012) in Ibadan, Osei et al. (2013) in Ghana, Yasin et al. (2015) in Ethiopia, Akpen et al. (2018) in Gboko, Nigeria (in which *E. coli* were found in some of the sachet waters only after 2 weeks of production), Addo et al. (2019) in Ghana and Opafola et al. (2020) in Abeokuta. It implied that no any pathogen was

found in all the sachet water samples considered, satisfying the limit permissible by WHO (2008) and NAFDAC ( $\leq 100$  cfu/mL for AMC and 0.00 cfu/mL for TCC) i.e zero tolerance of *E. coli* and thermotolerant in any 100 ml of drinking water. This showed consistency in adherence to GMPs by the producers. Almost similar results were obtained for both seasons which implied that seasonal variation might not influence the bacteriological quality of sachet water in the area of study.

## Conclusion

This study has confirmed that all sachet water tested were free from coliforms, other bacteria of interest, had zero *E. coli* tolerance, and were within the range of WHO and NAFDAC specified standards, hence, they are absolutely safe for consumption by the populace of Dutse metropolis. The nature of results obtained in this research is rare and has clearly indicated strict adherence to good manufacturing practices and high level of hygiene being maintained during production, storage, and distribution processes.

## Recommendations

There is need to consistently maintain strict hygienic measures, regulatory and surveillance activities of drinking water by the relevant bodies in order to continue to ensure production of safe drinking water which is vital to public health.

## CONFLICT OF INTEREST

The authors declare that they have no conflict of interest

## ACKNOWLEDGEMENT

The authors acknowledged the TETFUND sponsorship via

IBR grant and the Research Committee of Federal University Dutse, Jigawa State.

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