

**ASSESSMENT OF SAFETY AND SHELF LIFE OF
SACHET WATER PRODUCED AND SOLD IN
ILE-IFE, OSUN STATE, NIGERIA.**

A Dissertation by

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submitted to

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CERTIFICATION

This is to certify that this project was carried out by Adamu, Jacob Eshiemokhai with the

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DEDICATION

This work is dedicated to the glory of God Almighty who in his favour, has made this research project a success.

Also, to all the members of my supportive family, my friends and my lecturer for their love, care, tolerance, financial and moral support.

And to the memory of those families who, in one way or another, lost loved ones to the dreaded emerging and re-emerging infectious water diseases.

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ABSTRACT

Sachet water on sales have been identified to contain microorganism of public health significance and sometimes it is found to contain particles and off colour with many industries accused of packaging unprocessed water into sachet. This study was carried out to assess the safety and shelf life of the sachet water produced in Ile-Ife for consumption.

Fifteen sachet water industries were selected for this study using systematic sampling technique. Source water and freshly packaged sachet water samples collected at the industries were assessed at the baseline for coliform bacteria, colour, pH, conductivity, total suspended solids, calcium, chloride, magnesium, nitrates and hardness using W.H.O standard method for assessment of drinking water quality (APHA, 1998). Samples of sachet water that met W.H.O standards at baseline were stored in four different ambient conditions and assessed fortnightly over eight weeks. The results were analysed using descriptive and inferential statistics.

Enterobacter cloacae, *Citrobacter koseri*, *Pseudomonas aerogenes*, *Proteus ridgetti*, *Shigella dysenteriae*, and *aerobic spore's formers* were isolated in 46.7%, 40.0%, 20.0%, 6.7%, 26.6% and 20.0% of the source water samples respectively. *Enterobacter cloacae*, *Citrobacter koseri*, *Pseudomonas aerogenosa* and *Klebsiella aerogenosa* were isolated in 73.3%, 40%, 13.3% and 6.7% of the freshly processed sachet water samples and majority were susceptible to many commercially available antibiotics used in this study. Coliform bacteria were present in all the source water samples and 93.3% of the freshly prepared sachet water while 73.3% of the source water samples and 46.7% of the freshly prepared sachet water had total heterotrophic bacteria

above 100cfu/ml. The bacteria load was lower in freshly prepared sachet water and chloride was significantly higher. Coliform bacteria were not isolated in sachet water at 2, 4, 6 and 8 weeks but the bacteria load of sachet water was higher at 2 weeks and lower at 6 and 8 weeks. The physical and chemical parameter of source water and freshly prepared sachet water were negligible compared to the standard limits; the pH, 6.51-7.41, conductivity, 12.52-165.1 u/s, total dissolved solids, 7.50-98.90 mg/l, turbidity, 0.00-3.00 NTU, and concentration of nitrate, 0.00-1.20 mg/l, chlorides, 1.27-17.22 mg/l, magnesium, 0.00-7.39 mg/l and calcium 0.87-14.10 mg/l. Conductivity and dissolved solids were lower at 4 weeks while turbidity was higher at 6 and 8 weeks. The pH was higher at 8 weeks. The chloride concentration was higher at 2 weeks. The calcium and magnesium was lower at 6 and 8 weeks, and nitrate higher at 8 weeks. Nitrate, magnesium and calcium were significantly higher in sachet water exposed outside in the open air. And over three-quarter of the sachet water industries had adequate environmental hygiene.

It was concluded that the physical and chemical parameters of water samples from the original fifteen sachet water industries were within acceptable limit. However, non-faecal coliform bacteria were present and the total heterotrophic bacteria counts were unacceptable making the water unsafe for consumption. Of the fifteen sachet water industries, water samples from only one industry was fit for consumption because it has no coliform and the physical and chemical properties were within acceptable limit. Samples of this water after been stored in different conditions over eight weeks was found to be fit for consumption because coliform was absent and the total heterotrophic bacteria count, physical and chemical properties were acceptable.

CHAPTER ONE

INTRODUCTION

The supply of reliably wholesome drinking water that is colourless, odourless, tasteless, and free of pathogens is important (W.H.O, 2009) in promoting healthy living (Ajayi *et al.*, 2008). Up till date, availability of wholesome drinking water in the developing nations remains a critical and urgent problem with immense social and health concerns to homes, communities, government and international community (Oladipo *et al.*, 2009).

Packaged sachet water provides an alternative to the raging scarcity of hygienically safe and inaccessible public source of drinking water (Dada, 2009). In recent times, the consumption of sachet packaged water popularly known as 'pure water', continues to witness tremendous increase in Nigeria and other communities in the West Africa Sub-region (Oyededeji *et al.*, 2009). The consumers affairs movement of Nigeria stated in 2007 that the larger majority of the estimated three-quarter of Nigeria population that get their daily drinking water supply from sources other than public supply depend on it (Ajayi *et al.*, 2008). Sachet water was introduced as a less expensive means of accessing drinking water (Ogundipe, 2008), to reduce the enormous pressure of inadequacy in the provision of safe drinking water that has been attributed to increase human population and urbanization in the developing countries (Edema *et al.*, 2011). Moreover, there are controversies on the safety and quality of sachet water. It appears the regulators and producers of sachet water cannot guarantee what becomes of the product in term of storage and how long they can be kept for human consumption.

In addition, water-borne diseases such as diarrhoea, cholera, typhoid, gastro-intestinal disorders and skin infections are common health problems in most developing countries (Hunter *et al.*,

2001), and these health problems have been largely traced to unhygienic drinking water (Narasimhan and Himabindu, 2010).

It was estimated that 2.3 billion people suffered from diseases associated with poor drinking water and 1.8 million people are dying from diarrhoeal diseases yearly (W.H.O, 2004). Water-borne diseases pathogens are responsible for the majority of illnesses and deaths associated with drinking unsafe water, the diseases may impair living active life and possibly lead to absenteeism which subsequently brings about cut in workforce and national productivity (Hunter *et al.*, 2001).

The isolation of coliform bacteria which serve as an indicator of water quality or possible contamination, and many other water pathogens in sachet water continue to raise public health concerns in many Nigerian cities (Ezeugunne *et al.*, 2008, Ajayi *et al.*, 2008). In addition, long time water storage has been attributed to cause change in taste and smell (Tathagata, 2009). Although, the physical and chemical properties of water such as temperature, pH and turbidity, may enhance the proliferation of microorganism in water (Magna *et al.*, 2008), aid deterioration of sachet water and subsequently have effect on the colour, taste and odour of water. Studies have also shown that most sachet water brands fell below W.H.O drinking water standards and are therefore of doubtful quality and have public health implications (Oyedemi *et al.*, 2009, Dada, 2009, Ajayi *et al.*, 2008). In the study by Oyedemi *et al.*, all brands of sachet water sampled had total coliform, 20% had *E. coli* present while *E. faecalis* was recovered from 10% of the samples. In addition, multiple drugs resistance had been reported of coliform bacteria isolated from sachet water brands (Afiukwa *et al.*, 2011, Nwachukwu and Emerueme, 2007).

The National Agency for Food and Drug Administration and Control (NAFDAC) is an agency under the Nigeria Federal Ministry of Health charged with the responsibility to ensure strict adherence to international standards for regulation of sachet water. According to these standards, potable water must be of acceptable limits for bacteriological, physical and chemical indicators (W.H.O, 2006). This drinking water guideline standard indicates zero tolerance for coliform bacteria, total heterotrophic bacteria less than 100cfu per ml, and Turbidity, pH, dissolve solids and conductivity ranges from 0.1-5 NTU, 6.5-8.5, >500mg/l and >500u/s respectively while chlorides, calcium, magnesium and nitrate concentration below 250mg/l, 75mg/l, 50mg/l and 50mg/l are acceptable respectively (W.H.O, 2006).

1.1 Statement of the Research Problem

Water related diseases remain a source of concern in our environment. It still contributes immensely to hospital admissions in health centres across this country (Raji *et al.*, 2010). Hence, the availability of safe drinking water will alleviate the burden of diseases like cholera, typhoid fever and dysentery. The Federal Ministry of Health and various State Ministries of Health in Nigeria have reported increased number of cases of gastroenteritis, diarrhoea, typhoid and cholera which were indicative of poor drinking water quality (Raji and Ibrahim, 2011). Previous studies carried out in Ile-Ife have emphasised poor quality of sachet water (Oyedeji *et al.*, 2009). The developing countries have been faced with acute water shortage (Dada, 2009), poor quality of drinking water has been linked with outbreak of water borne diseases and these diseases caused high morbidity and mortality (Edema *et al.*, 2011). *Citrobacter*, *Enterobacter*, *Pseudomonas*, *Serratia* and *Shigella* species have been isolated from drinking water and have shown resistance to antibiotic (Payment *et al.*, 2003). Afiukwe *et al* (2011) also reported the resistance of the isolated coliform bacteria to multiple drugs.

The quality of water used, the storage conditions and time may determine the safety of sachet water (Hunter *et al.*, 2001). The quality of drinking water invariably is determined by the microbial content and the physical and chemical characteristics (pH, turbidity, temperature, conductivity and cation and anions) which indirectly may influence each other to determine the safety of the sachet water over storage period (Payment *et al.*, 2003). In addition, the environmental hygiene condition of many sachet water industries is of great importance because this may also have effect on the safety of the end product (France, 2012). The

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