

Consumption of sachet water in Nigeria: quality, public health and economic perspectives

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Demand for drinking water is met by different methods in different parts of the world. Water packaging into polyethylene sachets (as a form of water vending) has assumed an innovative status which has spread from its origin in Nigeria to other West African countries. This research examined the factors that birthed this product and the problems associated with sachet-packaged water (SPW) by reviewing relevant literature. In addition, 11 SPW samples were randomly procured from Oshodi/Isolo-Ota Expressway in Lagos and Ogun States of Nigeria, and analysed for contaminants. The analysed parameters include turbidity, total dissolved solids, nitrate and sulphate, which were found to be within the safe limits of the Standards Organisation of Nigeria's (SON) 5 NTU, 500 mg/l, 50 mg/l and 100 mg/l respectively in all the 22 SPW samples. Other tested parameters such as pH, hardness, cadmium and iron, however, were found to exceed the SON limits of 6.5–8.5, 150 mg/L, 0.003 mg/L and 0.3 mg/L respectively in some of the samples. It was concluded that in spite of the challenges associated with SPW, the product has export potential and could be a water supply solution in water-stressed situations such as refugee camps around the world.

Keywords: water quality, public health, economy, contaminants, packaging

JEL classification: Q25, Q28, Q30, O30, O55

Introduction

The use of water which is packaged in individual units of 50 centiliter high density polyethylene sachets is commonplace in Nigeria (Dada 2009, 19, Babatunde and Biala 2010, 113, Omoniyi and Abu 2012, 3, Fig. 1). This innovation, which was created as a direct response to the peculiar potable water needs of Nigerians, is referred to as 'pure water' in local parlance (Babatunde and Biala 2010, 113, Omoniyi and Abu 2012, 4). With the consumption of as many as 60 million units of the product per day, the advent of sachet-packaged water (SPW) in Nigeria in the early 1990s was driven by several factors among which are climatic, economic, and quality issues (Edoga et al. 2008, 642, Babatunde and Biala 2010, 113). Although the SPW originated in Nigeria, it has also been adopted in several other West African countries including Togo, Ghana, Côte d'Ivoire, Burkina Faso, Niger, Benin, and Cameroon (Stoler et al. 2012, 230). The common denominator among the enumerated countries is their location around the equator and the attendant high climatic temperatures.

Nigeria, being one of the sub-Sahara African countries, has average temperatures ranging between 21 °C–32 °C and 13 °C–41 °C in the southern and northern parts of the country respectively (Adejuwon 2004, Omole, et al. 2013, 89). Thus, the hot climate is a determining factor in the high demand for chilled SPW by commuters (Babatunde and Biala 2010, 113). To meet this demand, SPW vendors



Figure 1: Sachet-packaged water being marketed on a Nigerian roadside

transport it to roadsides and traffic build-ups for parched commuters (Stoler et al. 2012) (see Figure 1). Other forms of packaged water that are available in Nigeria include bottle-packaged water (which is patronised more by persons in the higher income brackets) and 'ice water' which is patronised by persons in the lower income bracket (Ikpe 2014, 110). The packaged water type which is referred to as 'ice water' in local parlance is often suspect with respect to quality. The 'ice water' is usually prepared by withdrawing water from nearby piped or vended water

sources. It is sometimes filtered with a piece of cloth and thereafter put into transparent linear low-density polyethylene (LLDPE) film grade plastic mini-bags (Okioga 2007, 38). Subsequently, the LLDPE bags are hand-knotted and cooled using ice blocks before being displayed for sale (Ikpe 2014, 110, 265, Stoler et al. 2012, 2, 14, Okioga 2007, 25). However, ‘ice water’ has been almost completely phased out for hygienic reasons and due to the advent of the better packaged SPW. The middle and low-income earners in Nigeria favor the SPW brand because of its better packaging and because of public perception that it is purer than the ‘ice-water’. Moreover, the average cost difference between SPW and bottle-packaged water is 1000% (Omoniyi and Abu 2012, 14–21). Thus, SPW is perceived as clean and affordable to a wide spectrum of people (Stoler et al. 2012, 225, Babatunde and Biala 2010, 114, Ikpe 2010, 111). The SPW, which goes for an average price of ₦5 (US\$ 0.03), is more expensive than ‘ice water’ which is sold for ₦1 (US\$ 0.006), but less expensive than bottled water which is sold for an average of ₦50 (US\$ 0.3) (Omoniyi and Abu 2012, 14–21). In a country where over 54% of its over 160 million people (FRN 2007, 1, Omole and Isiorho 2011, 208) live on less than US\$ 1/per day, paying for potable water has severe economic implications for the affected households (USAID 2010, 1). In the face of other competing household needs, paying as little as possible for clean drinking water is vital for the economic and physical wellbeing of ordinary people.

Furthermore, government’s incapacity to meet the provision of potable water for its citizens has contributed to the widespread dependence on SPW. In spite of its vast financial and natural water resources, Nigeria was identified as one of the few countries that is ‘unlikely’ to meet the United Nation’s Millennium Development Goal on water and sanitation by 2015 (Omole 2013, 9, UNICEF/WHO 2012, 6). Graft, weak water governing institutions, poor maintenance practices, energy failure, poor law enforcement and poor planning have been identified as some of the reasons why the provision of piped water services in Nigeria is elusive (Ajai 2012, 100–101, Omole and Ndambuki 2014, 5189–5190, Omole and Ndambuki 2015).

Nearly one decade after SPW was introduced into the Nigerian market, the Federal Government of Nigeria tasked the National Agency for Food and Drug Administration Control (NAFDAC) with the regulation of the sector (Babatunde and Biala 2010, 114). In order to achieve this, NAFDAC set out a number of conditions and quality criteria prior to business registration (Akunyili 2003, 85). About 134 sachet and bottled water producing companies that met the criteria became the official pioneers when they became registered in 2001 (Akunyili 2003, 86, Babatunde and Biala 2010, 115). With the endorsement of quality by NAFDAC, public confidence in the product increased, and so did the demand for the

product (Akunyili 2003, 85, Babatunde and Biala 2010, 115). Unending demand for the SPW thus made the packaged water producing sector of the economy very attractive to would-be small-scale investors. This created a unique income-generating opportunity that required relatively low start-up capital for thousands of investors. Further, the industry provided employment such as packing, vending and distribution for people in the downstream sector of the packaged water industry (Chendo 2013, 187, Adewoye and Akanbi 2012, Ikpe 2014, 110–111).

Over the years, however, NAFDAC has not been able to keep up with the regulatory needs due to high rates of proliferation by different SPW business operators (Dada 2009, 17, Omoniyi and Abu 2012, 3). The demand for SPW by the public, on the other hand, keeps increasing and so does the revenue stream from sales (Mojekeh and Eze 2011). There have been pockets of reports regarding health problems created by quality issues arising from the consumption of SPW (Dada 2009, Babatunde and Biala 2010, Longe et al. 2012). Likewise, there have been concerns regarding the waste generated from the discarded polyethylene packages (DPP). Often, users leave the DPP wherever the product was used, thus creating large volumes of non-biodegradable waste on a daily basis (Edoga et al. 2008, Babatunde and Biala 2010, Mojekeh and Eze 2011, 480–482). This research, therefore, focused on the assessment of the opportunity costs and benefits occasioned by the use of SPW in Nigeria. This was done with a view to proffering solutions that would help maximise the benefits of SPW in Nigeria and other developing countries that have similar problems. The research also aims at proffering strategies for remediating the adverse effects of SPW on people and the environment.

Materials and methods

Study area

The sampling study was conducted on a 33.5 km corridor between Oshodi/Isolo, Lagos State and Ota, Ogun State, in Nigeria. This corridor was chosen as the study area because it is one of the busiest routes in Nigeria in terms of vehicular and pedestrian traffic (VN 2010). A 2009 study showed that 6 million passengers were serviced by the Lagos State run Bus Rapid Transit within a space of one year (Omole and Ndambuki 2014, Mobereola 2009). This is besides the population that was served by private transportation operators. Due to the busy traffic, the 33.5 km journey, which could be covered in 40 minutes under normal circumstances, may take as much as two hours (VN 2010). This difficulty in the transportation system, coupled with the high climatic temperatures make the route a target for sachet water hawkers (Edoga et al. 2008, 642).

Quality issues

The quality of packaged water being sold on this corridor was assessed by randomly purchasing eleven different SPW brands at an average interval of 3 km between stops from persons hawking the products at traffic stops along the Oshodi/Isolo-Ota corridor. Two samples each of 6 different brands were purchased between Oshodi-Isolo and Ajegunle, within the Lagos boundary, while five brands were purchased between Toll Gate and Iyana-Iyesa, in Ota, Ogun State. All the purchased SPW samples had NAFDAC registration numbers on them. These SPWs were taken to Anila Resources (a private research laboratory in Lagos State, Nigeria) for physico-chemical analysis. The parameters which were analysed included pH, total dissolved solids (TDS), hardness (as CaCO_3) and turbidity. Others were sulphate (SO_4), nitrate (NO_3), cadmium (Cd) and iron (Fe). The selected heavy metals were included in the analysis because they are common problems associated with water quality in south-west Nigeria (Ogunmola et al. 2014, 1, Longe et al. 2012, 2, Omole and Longe 2008, Omole 2011). A Horiba Compact B-212 pH meter was used to determine the pH of the water samples. A direct reading spectrophotometer (model DR/2000) was used for the determination of turbidity, salinity and TDS. Other parameters were determined using standard methods for the examination of water (APHA 2005). Furthermore, the qualities of randomly sampled SPW in other parts of the country were assessed by reviewing published literature on the subject. The results were compared with the Standards Organisation of Nigeria's National Standard for Drinking Water Quality (SON 2007).

Economic and public health issues

Information on the economic benefits of SPW and its impact on public health were sourced from literature and are also discussed.

Results and discussion

The laboratory results showed that all the eleven sampled SPW were within the safe limits of the NSDWQ standards of 5 NTU, 500 mg/l, 50 mg/l and 100 mg/l for turbidity, TDS, NO_3 and SO_4 respectively. However, some of the sampled SPWs exceeded the NSDWQ safe limits for pH, hardness, Cd and Fe to varying degrees.

pH

pH is the measure of hydrogen ions in water (SON 2007, 15, WHO 2007, 2). It is usual for pH in natural, untreated water to be low due to the mixture of atmospheric carbon dioxide with precipitation (WHO 2007). Also, different salts and metal compounds are dissolved in water as it percolates towards the aquifers (Omole et al. 2014, 1, Egboka et al. 1989, 49). Although pH has no known adverse impact on health (SON 2007, 15), it is a very important water quality parameter as it provides a lot of information about the source, physical state, and the presence of other

possible contaminants in water. Analysis of the sampled SPW showed that the pH value of 73% of the water samples was acidic and outside the NSDWQ approved range of 6.5 to 8.5 (Figure 2). This suggests that most of the SPW companies did not treat the raw water for pH before packaging. It is common for people to assume that groundwater is pure and therefore fit for consumption (Egboka et al. 1989, 59). This is mostly untrue as groundwater can be exposed to a lot of natural and human-induced pollutants (Omole 2013, 9, Glynn and Plummer 2005, 265, Banks et al. 1997, Egboka et al. 1989, 59).

Cadmium

Fifty-five percent (55%) of the sampled SPW had Cd levels exceeding the maximum limit of 0.003 mg/L (Figure 3). The water samples having high Cd contaminants exceeded the SON (2007, 16) maximum contaminant level of 0.003 mg/L by as much as 220% to 2 700% (Figure 3). Cadmium is a heavy metal which does not metabolise once it gets into the human body. Rather, it bio-accumulates in the kidneys, which later leads to kidney

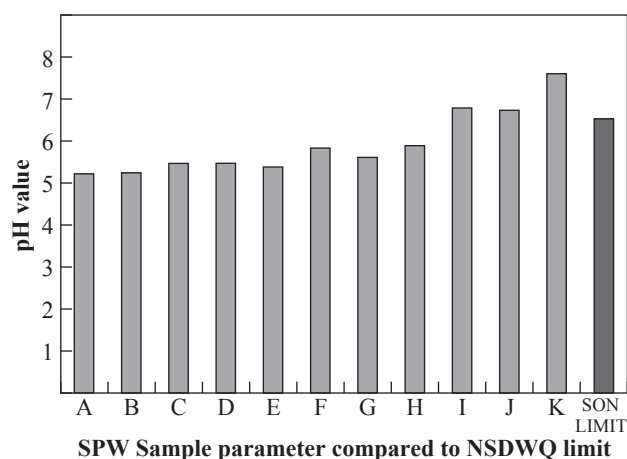


Figure 2: pH value of all the sampled SPW

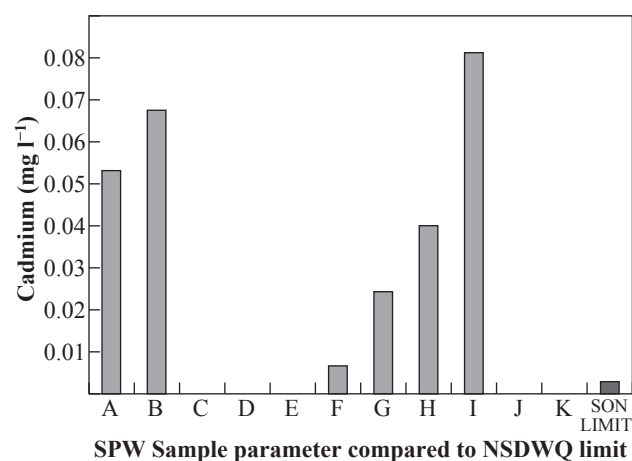


Figure 3: Cadmium levels of all the sampled SPW

failure. Although Cd exists through natural deposits in soils, heightened Cd levels in the environment may also be induced by anthropogenic activities such as application of pesticides, fungicides, and fertilisers. It may also occur as a by-product of the manufacture of batteries, paints and metallurgical products among other activities (Omole 2011, 208, Egboka et al. 1989, 61). Thus, cadmium reaches fresh water sources either through leached cadmium from ambient soil or through surface run-off from manufacturing, agricultural and/or domestic wastes. Cadmium has been found consistently in surface and groundwater samples in some parts of south-west Nigeria (Longe et al. 2012, 2, Omole 2011, 33, Mgbachi 2010, 45, Ifatimehin 2007, 42). Therefore, the SPW manufacturers ought to be made aware of location-specific contaminants in order to treat the water efficiently before the packaging process. Currently, the standard practice is to treat raw water using custom-built machines imported from China (Okioga 2007, 30, Stoler et al. 2012, 227). These machines are equipped to treat biological contaminants and some other contaminants. However, they are not designed to address location-specific contaminants (Stoler et al. 2012, 227).

Iron

Thirty-six percent of the analysed water samples exceeded the SON limit of 0.3 mg/L for Fe by a range of 117% to 226% (Figure 4).

Iron is the second most abundant mineral in soils and a common natural deposit in lateritic soils (Abbaspour et al. 2014, 1, Quinterro-Gutierrez et al. 2008, 58, Kehinde and Longe, 2003, 10, Egboka et al. 1989). Most of Nigeria's coastal areas are underlain by the Benin Formation, which extends from Togo to beyond the Niger Delta. It is predominantly sandstone in formation and has interleaved layers of shale. The upper surface is lateritic and exhibits some deltaic depositional environment (Kehinde and Longe 2003, Isiorho 2001, 957). Thus, the iron found in the lateritic soil

materials easily dissolves in groundwater. The presence of Fe in some of the water samples found in south-west Nigeria is connected to the fact that groundwater is the primary source of potable water in Nigeria (Omole 2013, 9, Longe et al. 2012, 2). Although iron is essential to all organisms, the formation of free radicals of iron in the body can lead to tissue damage and possible neuro-degenerative diseases (Abbaspour et al. 2014, 1, Iannotti et al. 2006, 1266). Excessive iron content in water also creates other problems such as stains on the teeth, porcelain ware and toilet ceramics (Iannotti et al. 2006, 1266).

Hardness

Water hardness is commonly attributed to high concentrations of calcium and magnesium ions in it. However, the dissolution of other metals such as zinc, aluminum, strontium, barium, iron, and manganese can also cause water hardness (Chandra et al. 2013, 454). Water hardness can be subdivided into temporary and permanent hardness. While the former is composed of carbonates and can be treated by boiling, the former is caused by a combination of metals with non-alkalis and are known as permanent hardness because they cannot be treated by boiling (Sengupta 2013, 2). All the sampled SPW exceeded the specified SON (2007, 16) limit of 150 mg/L for hardness (as a function of calcium carbonate (CaCO_3)) by a range of 267% to 393% (Figure 5).

Traditionally, hardness in water was not taken as a major or life threatening problem (SON 2007, 16, Sengupta and Sahoo 2013). In fact, it is thought to be beneficial as the calcium and magnesium contents are known to aid bone formation, among other health benefits (Sengupta and Sahoo 2013, Chandra et al. 2012). However, recent research suggests that the level of the hardness should be controlled as many people are found to be sensitive to some constituents of hard water (Sengupta 2013, 2, Chandra et al. 2013, Sengupta 2012, 61). Certain diseases such as atopic dermatitis in children have been

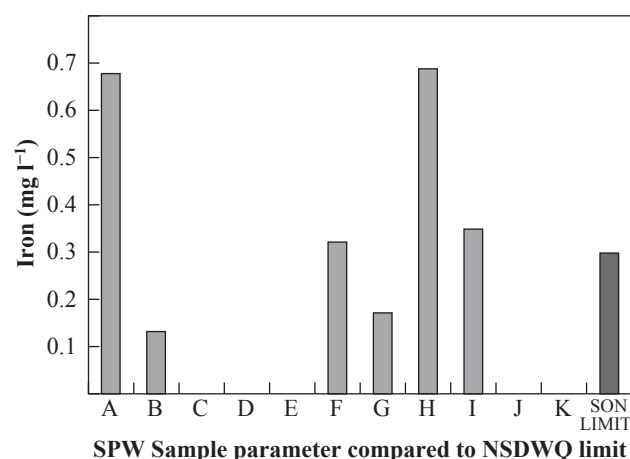


Figure 4: Iron levels of all the sampled SPW

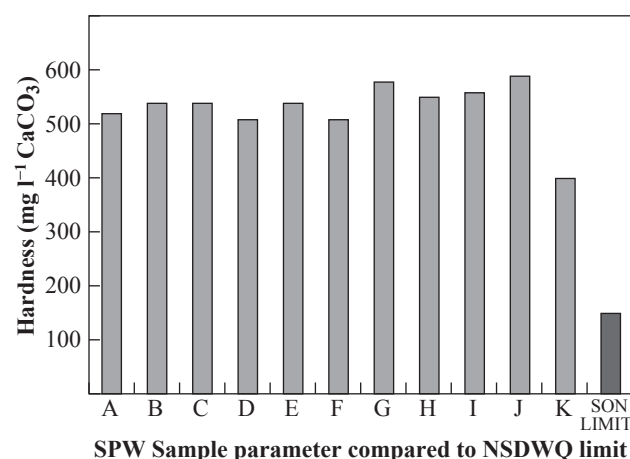


Figure 5: Hardness levels of all the sampled SPW

linked to water hardness (Sengupta, and Sahoo 2013, 173, Sengupta 2012, Miyake et al. 2004). Also, other studies recommended that persons with urinary problems caused by kidney stones should take soft water since 75% of kidney stones are composed of calcium salts (Sengupta and Sahoo 2013, 172, Bellizzi et al. 1999, 67). Several other ailments and bodily discomforts have also been linked to metabolic incapacity to excrete excess calcium or magnesium, thus making it necessary to regulate water hardness (Chandra et al. 2013, Sengupta and Sahoo 2013, Bellizzi et al. 1999, 68).

The National Agency for Food and Drug Administration Control, NAFDAC, is responsible for the issuance of licenses to registered operators. These operators are expected to print their license number on their product to enable the regulatory body to identify the product origin in cases requiring enquiries (Akunyili 2003, 1). The licensing procedure requires the investor to file an application, following which NAFDAC officials will visit the factory. The officials inspect the facilities mainly to determine if the SPW production process is hygienic (Omoniyi and Abu 2012, 6). The problem with the packaged water industry, however, is the attitude of many of the operators whose sole reason for marketing SPW is economic (Babatunde and Biala 2010, 115; Akunyili 2003, 2). A random nationwide survey by NAFDAC on registered SPW products in 2002 showed that 52% of the products failed the quality test due to microbial contaminants, while another 22% failed the quality test due to the presence of chemical contaminants (Akunyili 2003, 2).

As a result of public health problems arising from the consumption of impure SPW, calls for an outright ban on SPW became rampant (Babatunde and Biala 2010, 118). In order to address the problem, NAFDAC proposed a plan for the gradual winding down of the SPW industry and its metamorphosis into bottle-packaged water (Chendo 2013; Babatunde and Biala 2010). Rather than winding down, however, the SPW practice has grown by leaps and bounds. Within a space of two years (2001–2002), the number of registered SPW manufacturers nationwide rose from 134 to 998 (representing an increase of 745%) (Akunyili 2003, 2). Drawing from the research by Chendo (2013), it can be inferred that an estimated 10 000 registered SPW manufacturers operate in Nigeria (Chendo 2013). This is besides a large population of illegal and unregistered manufacturers and distributors. A research survey conducted by Babatunde and Biala (2010, 130) in Kwara State indicated that 70% of the sampled population did not agree with the phasing out of SPW from the Nigerian market. Reasons for this were adduced to low access to piped water facilities in living quarters as well as general public distrust of the quality of piped water in places where they do exist. Other reasons are connected to the fact that the SPW industry provides employment to hundreds of thousands of ordinary Nigerians, considering that more than 60 million units of the products are consumed per day (Chendo 2013,

Babatunde and Biala 2010, Edoga, et al. 2008, Akunyili 2003). Therefore, there is a conflict between protecting public health and protecting the sources of livelihood of several thousands of people.

Conclusions

The invention of SPW in Nigeria is an innovative solution that has met the drinking water needs of a wide range of consumers in Nigeria and several other African countries. It is also a solution that caters for the gap created by insufficient piped water services to individual households in the affected countries. Its success is due in large part to public acceptance and perception of SPW as an alternative source of clean drinking water. Like all inventions, however, there is always room for improvement. The bulk of the problems associated with SPW are more related to human behavioural patterns than the product itself. Hence, it will not be in the interest of the served population to eradicate SPW based simply on quality or waste generation issues. Rather, efforts should be intensified to address the attitudinal challenges. The operational effort of the regulatory agency, NAFDAC, should be expanded by providing it with more trained personnel, financial resources and adequate legal backing to fight the scourge of profiteering at the expense of public health by some SPW manufacturers. NAFDAC operations should be expanded to include well-furnished laboratories for constant random sampling of SPW across the 36 Administrative States, the Federal Capital Territory and the 774 local government areas of the Federation. Furthermore, NAFDAC should be legally empowered to shut down illegal operations, make arrests, and prosecute offenders.

Since water quality and water treatment requirements are not uniform in different geographical locations, the peculiar water quality needs of the different LGSs should be identified, specified and recommended to the SPW manufacturers in the different localities. NAFDAC should also be mandated to conduct routine and unscheduled visits to the SPW factories in order to check sharp practices. There is also a need for the organisation of routine workshop training for the SPW manufacturers and personnel workers, most of whom have no formal education on water quality issues (Stoler et al. 2012, 227, Omoniyi and Abu 2012, 2). All these are necessary because, aside from the employment opportunity provided by the SPW industry in Nigeria, it also has a potential to generate foreign exchange through exportation of the product. Further, it can be adapted as an economical solution for other water-stressed countries or refugee camps in different parts of the world where relief materials such as potable water are in demand.

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