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

David O. Omole aM, Julius M. Ndambuki'and Kehinde Balogun

Department of Civil *Engineering, Tshwane University of Technology, Pretoria, South Africa*
Department of Civil *Engineering, Covenant University, Ota, Ogun State, Nigeria*
Department of Civil *Engineering, Tshwane University of Technology, Pretoria, South Africa*
Corresponding author email: david.omole@covenantuniversity.edu.ng

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 ofNigeria's (SON) 5 NTU, 500 mg/1, 50 mg/1 and 100 mg/1 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, 030, 055

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, Cote 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 OC and 13 °C-41 OC 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 lovv-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 eamers in Nigeria favor the SP\.V brand because of its better packaging and because of public perception that it is purer than the 'ice-\vater'. :tv1oreover, the average cost difference between SP\:V and bottle-packaged water is 1000% (Omoniyi and Abu 2012, 14···21). Thus, SP\V is perceived as clean and affordable to a wide spectnm1 of people (Stoler et al. 2012, 225, Babattmde and Biala 2010. 114, Ikpe 2010, 111). The SPW, which goes for an average price of N5 (L:S$ 0 03), is more expensive than 'ice water' which is sold for N1 (CSS 0.006), but less expensive than bottled water which is sold for an average of N50 (CS$ 0.3) (Omoniyi and Abu 2012, 14-21). l.n a country where over 54% of its over 160 million people (FRN 2007, I. Omole and Isiorho 2011, 208) live on less than L:SS !/per day, paying for potable water has severe economic implications for the affected households (US•\JD 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 \videspread dependence on SP\V. rn 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 1\ation's J\-1ilknnium Dcvdopment Goal on water and sanitation by 2015 (Omole 2013, 9, lJNICEF/\:VHO 2012, 6). Graft, weak water governing institutions, poor maintenance practices. energy t 1ilure, poor lmv enforcement and poor planning have been identified as some of the reasons why the provision of piped water services in Jigeria is elusive (Ajai 2012, 1()()....1 01, Omole and Ndambuki 2014, 5189-5190, Omole and Ndambuki 2015)

Nearly one decade after SP\V vvas introduced into the Nigerian market, the Federal Government of Nigeria tasked the National Agency for Food and Dmg Administration Control (NA.FDAC) 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 (Aku:nyih 2003, 85). About 134 sachet and bottled \Vater producing companies that met the criteria became the official pioneers v.'hen 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 fhe 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, lkpe 2014, 110-111)

Over fhe years, however, NAFDAC has not been able to keep up \Vith the regulatory needs due to high rates of proliferation by different SP\V business operators (Dada 2009, 17, Omoniyi and Abu 2012, 3). The demand for SP\V by the public, on the other hand, keeps increasing and so docs the revenue stream from sales (Jvlojckeh and Eze 2011). There have been pockets of reports regarding health problems created by quality issues arising from the consumption of SP\V (Dada 2009, Babatunde and Riala 2010, Longe et al. 2012). Like\vise, there have been concerns regarding the \Vaste generated from the discarded polyethylene packages (DPP). Often. users leave the DPP wherever the product \Vas used, thus creating large voltunes of non-biodegradable waste on a daily basis (Edoga ct al. 200R. Babatcmdc and Bia1a 2010, Mojckch and Eze 2011, 480-482). This research, therefOre, focused on the assessment of the opporttmity costs and benefits occasioned by the use of SP\V in 1\igeria. This was done \'.'ith a view to proffering solutions that would help maximise the benefits of SP\:V in ;.:J"igeria and other developing countries that have similar problems. The research also aims at proffering strategies for remediating the adverse effects of SP\.V on people and the environment.

Materials and methods

Study area

The sampling study was conducted on a 33.5 km corridor between Oshodii.l solo, Lagos State and Ota, Ogw1 State, in 1\igeria. This corridor was chosen as the study area because it is one of the busiest routes in Nigeria in tenns of vehicular and pedestrian tra!Tic (VN 2010). 1\ 2009 study shmved that 6 million passengers were serviced by the Lagos State nm Bus Rapid Transit within a space of one year (Omole and Ndambuki 2014, Mobereola 2009). This is besides the population lhal was served by private transportation operators. Due to the busy tra±Iic, the 33.5 km journey, which could be covered in 40 minutes under nonnal 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-Iyesi, 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 (IDS), hardness (as $CaC0_3$) and turbidity. Others were sulphate ($S0_4$), nitrate ($N0_3$), 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 etal. 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 IDS. 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 ofNigeria'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/1, 50 mg/1 and 100 mg/1 for turbidity, IDS, $N0_3$ and $S0_4$ 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

colates 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 bioaccumulates in the kidneys, which later leads to kidney

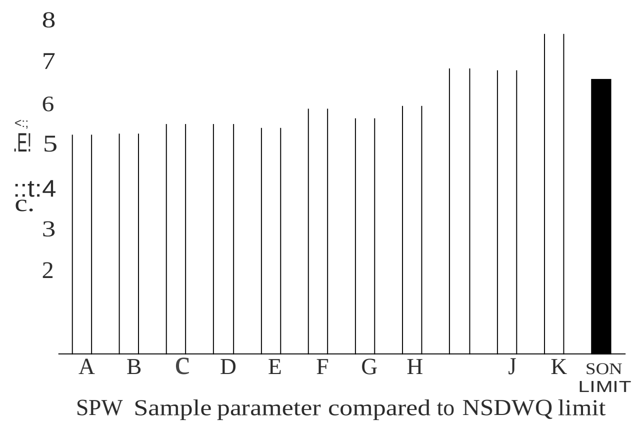

Figure 2: pH value of all the sampled SPW

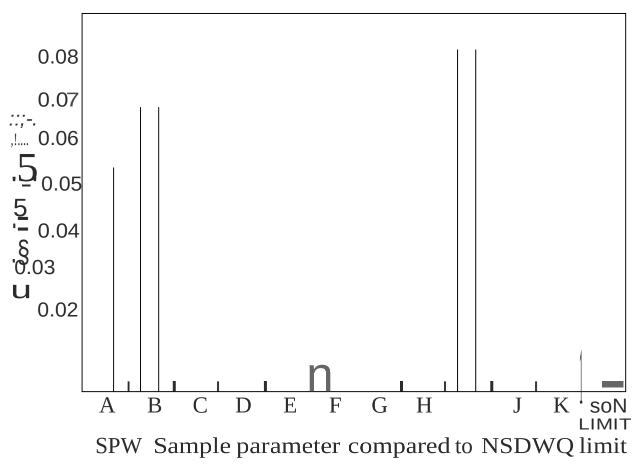

Figure 3: Cadmium levels of all the sampled SPW

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, :tvfgbachi 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 ($CaC0_3$)) 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

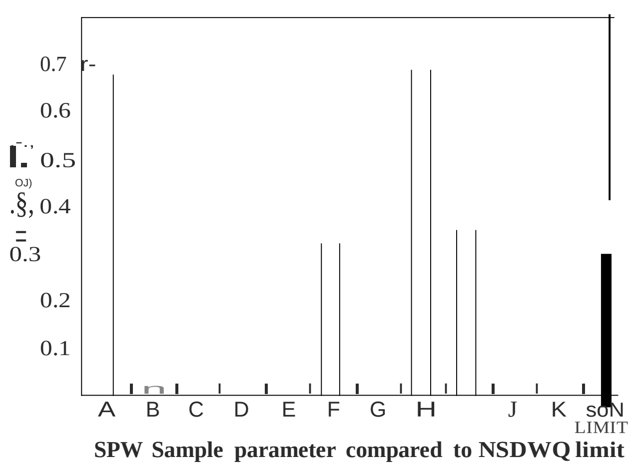

Figure 4: Iron levels of all the sampled SPW

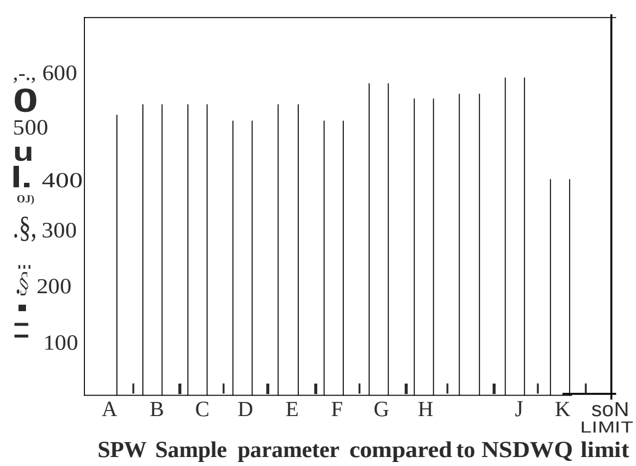

Figure 5: Hardness levels of all the sampled SPW

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 soil water since 75% of kidney stones are com posed 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 vvater hardness (Chandra cl al. 2013, Sengupta and Sahoo 2il13, Bellizzi et al 1999, 68).

The 1\ational Agency for Food and Drug Administration Control, ;.JAFDAC 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 tile an application, following which NAFDAC oi1icials will visit the factory. The officials inspect the lflcilities mainly to detennine if the SP\V production process is hygienic (Omoniyi and Abu :2012, 6). The problem with the packaged V.'ater industry, however, is the attitude of many of the operators whose sole reason for marketing SP\V is economic (Babatunde and Biala 2010, 115; Akunyili 2003, 2). A random nationvvidc survey by -NAFDAC on registered SP\V products in 2002 showed that 52% of the products i 1iled the quality test due to microbial contaminants, v.'hile another 22% failed the quality Lest due to the presence of chemical contaminants (i\kunyili 2003, 2).

1\s a result of public health problems arising from the consumption of impure SP\V, calls for an outright ban on SPW became rampant (l3abatunde and Biala 2010, 118). In order to address the problem, _NAFDAC proposed a plan for the b:rradual winding down of the SP\V industry and its metamorphosis into bottle-packaged water (C:hendo 2013; Babatundc and Biala 2010). Rather than winding down. hmvcvcr, the SP\V practice has grow11 by leaps and hounds. Within a space of two years (2001-2002), the number of registered SP\V manufacturers nationwide rose from 134 to 998 (representing an increase of 745%) (Akunyih 2003. 2). Drawing ti·om the research by Chendo (2013), it can be inferred that an estimated Ill 000 registered SPW manufacturers operate in Nigeria (Chcndo 2013). This is besides a large population of illegal and unregistered manufacturers and distributors. A research survey conducted by Babatw1de and Biala (2010, 130) in Kwara Slate indicated that 70% of the sampled population did not agree with the phasing out of SP\V from the }Jigerian market. Reasons for this Vv'crc 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 i tct that the SP\V industry provides employment to hundreds of thousands of ordinary Nigerians, considering that more than 60 million units of the products arc consumed per day (Chcndo 2013, Babattmde 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 thousanct<; of people.

Conclusions

The invention of SP\V 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. _[tis also a solution that caters for the gap created by insufficient piped water services to individual households in the affected cmmtries. Its success is due in large part to public acceptance and perception of SPVV as an altcmativc source of clean drinking water. Like all inventions, hmvever, there is ahvays room for improvement. The bulk of the problems associated \Vith SP\V are more related to human behavioural patten1s than the product itself Hence, it will not be in the interest of the served poptliation to eradicate SP\V based simply on quality or vmstc generation issues. Rather. cfforls 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. \JAFDAC operations should be expanded to include \Veil-furnished laboratories for constant random sampling of SP\V across the 36 Administrative States, the Federal Capital Territory and the 774 local government areas of the Federation. Furthermore, Ni\FDAC should be legally empowered to shut down illegal operations, make arrests, and prosecute offenders.

Since water quality and water treatment requirements arc not tmiforn1 in diiTerent geographical locations, the peculiar \'.'ater quality needs of the different LG-Ss should be identified, specified and recommended to the SPW manuiclcturers in the different localities. KAFDAC should also be mandated to conduct routine and unscheduled visils to the SP\V factories in order to check sharp practices. There is also a need for the organisation of routine workshop training for the SP\V manufacturers and personnel workers, most of whom have no formal education on water quality issues (Stoler ct al. :2012. 227, Omoniyi and Abu 2012. 2). All these arc 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 -..vater-stressed countries or refugee camps in different parts of the world \Vhcrc relief materials such as potable vvatcr arc in demand.

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