Waterborne diseases transmission potential of sachet waters sold in Owerri, Eastern Nigeria

ABSTRACT:

The monitoring of packaged water quality in Nigeria should not stop production but extended to post production quality assurance to ensure prevention of public health consequences associated with sachet water contamination. Triplicate samples of some locally available sachet waters were collected randomly from markets in Owerri and subjected to standard microbiological analysis. Sachet water samples analysed include samples from Agad, God is able, Davimor, Linkmor and Mr Ben branded products. The Total Heterotrophic Bacterial Count (THBC) counts ranged between $2.0 \times 10^2$ to $1.0 \times 10^1$ cfu/ml while the Total Coliform Bacterial Count (TCBC) count ranged between $1.2 \times 10^0$ to 0 cfu/ml. Highest growth was recorded in Davimor while the lowest was in Agad. The isolates occurred thus: Pseudomonas aeruginosa, Salmonella typhi and Shigella dysenteriae in Davimor; Bacillus subtilis, Salmonella typhi and Shigella dysenteriae in Linkmor and Pseudomonas aeruginosa, Bacillus subtilis, Salmonella typhi and Shigella dysenteriae in Mr Ben samples; Pseudomonas aeruginosa and Bacillus subtilis both in Agad and God is able samples. The counts were below the Maximum Contaminant Levels (MCL) for drinking water. The sachet water samples have potable water quality. Salmonella typhi is responsible for two types of salmonellosis: typhoid fever and gastroenteritis. Shigella dysenteriae in samples implied possible risk of outbreak of shigellosis. Pseudomonas aeruginosa and Bacillus subtilis might be responsible for degradation of packaging material and production of odor and taste compounds. Post production quality analysis should be routinely carried on sachet waters in the market to prevent and control waterborne bacterial diseases.

Keywords:
Sachet water, public health, waterborne diseases, post production quality, quality standards.

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INTRODUCTION

The sale and consumption of packaged water continues to grow rapidly in most countries of the world. In Nigeria particularly, there is an astronomical increase in the consumption of packaged waters especially bottled and sachet drinking water. The increased demand for these drinking water products is attributed largely to factors such as inadequate or non availability of reliable, safe municipal water in urban areas; impression that high quality natural spring water and drinking water offer a healthy, refreshing and great tasting alternative to high calorie soft drinks and ordinary tap water; and convenience which has made the products meet the requirements of any lifestyle when needed (Gardner, 2004).

The sachet drinking water was introduced into the Nigerian market as a less expensive means of accessing drinking water than bottled water (Ogundipe, 2008). It also acts as an improvement over the former types of drinking water packaged for sale to consumers in hand filled, hand tied polythene bags. Today, the easy accessibility to drinking water in packaged forms has resulted in a big and thriving water industry with several hundreds of million litres of these water products consumed every year by Nigerians (Ogundipe, 2008).

Several studies on the microbial quality of bottled and sachet water have reported violations of international quality standards. In a Canadian study, screening of bottled water for indicator bacteria revealed that 3.7% of the samples had total coliforms and 23.3% of the 3460 samples had more than 100 colonies of heterotrophic bacteria per ml of sample (Warburton et al., 1998). A similar study of brands of bottled water in Trinidad showed that 18 out of the 344 samples checked revealed the presence of total coliforms while five of the samples had Escherichia coli and colonies of Enterococcus faecalis were occasionally detected in the samples (Bharath et al., 2003). The quality monitoring of sachet water in Nigeria has been documented (Adekunle et al., 2004; Onifade et al., 2008; Dada, 2009). However, there is little information in scientific literatures on the quality of the many brands of sachet water produced and marketed by local companies.

Water borne diseases continue to be one of the major health problems especially in developing nations. The high prevalence of diseases such as typhoid fever, diarrheal diseases such as cholera and bacillary dysentery among the populace has been traced to the consumption of unsafe water and unhygienic drinking water production practices (Mead et al., 1999). The most dangerous form of water pollution occurs when faecal contaminants enter the water supply. Pathogenes such as Salmonella species, Shigella species, Vibrio cholerae and E. coli being shed in human and animal faeces ultimately find their way into water supply through seepage of improperly treated sewage into ground water (DiPaola, 1998).

In Nigeria, the National Agency for Food and Drug Administration and Control (NAFDAC) is the parastatal under the Federal Ministry of Health, charged with the responsibility for the regulation and control of imported and locally processed foods and water products (Omotayo et al., 2002). To ensure strict adherence to international standards, NAFDAC’s regulation for bottled and sachet-packed water in Nigeria has been put at the standards established by the World Health Organization (WHO). According to these standards, potable water for human consumption must be free of microbial indicators of faecal contamination and coliform count per 100 ml of drinking water must be zero (World Health Organization, 1997; Pierre, 1999).

Owerri metropolis is a highly urbanized area in South Eastern Nigeria where several brands of bottled and sachet water are vended to the public. The continuous proliferation of these packaged water products and their indiscriminate consumption are of public health significance. An understanding of their microbiological quality and safety are therefore imperative (Drinking Water Research Foundation, 2004). This study therefore aims at providing information for the safety of packaged drinking water marketed in selected areas of Owerri, Nigeria by determining the bacteriological quality of several of the brands. This will give an understanding of the extent to which the products meet the standards and recommendations of the World Health Organization (WHO).

MATERIALS AND METHODS

Study area:

The study area was Owerri Municipal in Imo State, comprising of Umuoronjo, Umunyeche, Umuodu, Umuoyima and Amawom villages.

Sample collection:

Samples from five sachet water companies namely: Agad, God is able, Davimor, Linkmor and Mr Ben were collected randomly triplicates from
markets and immediately transported to the laboratory for microbiological analysis.

**Microbiological analysis:**

Sterilization of media was carried out by moist heat sterilization method using autoclave at 121°C, 15psi and for 15 minutes. Heat stable materials were sterilized using hot air oven at 160°C for 1 hour as described by Cruickshank et al. (1982). Heat labile materials were aseptically rinsed with alcohol and distilled water. The media used include Nutrient agar, MacConkey agar, Eosin Methylene Blue agar, TCBS, and Salmonella – Shigella agar. All media were prepared as directed by the manufacturer. Spread plates of samples were incubated at 37°C for 24 hours for heterotrophic bacterial count (THBC) while total coliform bacterial count (TCBC) were determined after incubation at 45°C for 24 hours in MacConkey agar. Identification of isolates was based on the scheme described by Cheesbrough (1984).

**RESULTS AND DISCUSSION**

**Result:**

The result of Total Heterotrophic Bacterial Count (THBC) and Total Coliform Bacterial Count (TCBC) (cfu/ml) are as shown in Table 1. Sachet water samples include samples Agad, God is able, Davimor, Linkmor and Mr Ben. The THBC counts ranged between 2.0x10^4 to 1.0x10^5 while the TCBC count ranged between 1.2x10^0 to 0 cfu/ml. Highest growth was recorded in Davimor while the lowest was in Agad. There were no growths on MacConkey agar, Eosin Methylene Blue agar, TCBS, and Salmonella – Shigella agar media for Agad and God is able samples; while there were growths on MacConkey and Salmonella – Shigella agars for Davimor, Linkmor and Mr Ben samples.

**Table 1: Bacterial Count (cfu/ml) of sachet water samples**

<table>
<thead>
<tr>
<th>Sachet water brands</th>
<th>THBC</th>
<th>TCBC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agad</td>
<td>1.0x10^4</td>
<td>-</td>
</tr>
<tr>
<td>God is able</td>
<td>1.2x10^4</td>
<td>-</td>
</tr>
<tr>
<td>Davimor</td>
<td>2.0x10^2</td>
<td>1.0x10^0</td>
</tr>
<tr>
<td>Linkmor</td>
<td>1.4x10^3</td>
<td>1.2x10^0</td>
</tr>
<tr>
<td>Mr Ben</td>
<td>1.1x10^3</td>
<td>1.0x10^0</td>
</tr>
</tbody>
</table>

**Total Heterotrophic Bacterial Count = THBC**  
**Total Coliform Bacterial Count = TCBC**  
**Nil = -**

**Table 2** shows the morphological characteristics and biochemical reactions of bacteria isolates from the sachet water samples. **Table 3** shows the bacterial isolates in Sachet water samples. The isolates occurred thus: *Pseudomonas* spp., *Salmonella* spp. and *Shigella* spp. were present in Davimor; *Bacillus* spp., *Salmonella* spp. and *Shigella* spp. in Linkmor and *Pseudomonas* spp., *Bacillus* spp., *Salmonella* spp. and *Shigella* spp. in Mr Ben samples; *Pseudomonas* spp. and *Bacillus* spp. both in Agad and God is able samples.

**DISCUSSION:**

The prevalence of water related diseases in developing countries is determined by the quality of their drinking water. The safety of drinking water in poor and deprived communities has been in jeopardy as a result of wanton introduction of refuse and sewage into sources of water supply. The introduction of the sachet drinking water in the Nigerian market was a laudable idea but studies suggest that this innovative idea is not risk free (Obiri-Danso et al., 2003).

The coliform test is a reliable indicator of the possible presence of fecal contamination and is, consequently, correlated with pathogens. The USEPA Maximum Contaminant Level (MCL) is less than one coliform per 100ml (USEPA, 2003). The Total Heterotrophic Bacteria Count (THBC) test also called “total count” or “plate count”, provided an estimate of the total number of bacteria in a sample that will develop into colonies during a period of incubation in a nutrient. This test detected a broad group of bacteria including pathogens, and opportunistic pathogens, but it does not pretend to report all of the bacteria in the water sample examined. THBC may be an indicator of poor general biological quality of the sachet water samples. This corroborates the report of USEPA (2003).

Health agencies like the USEPA and World Health Organization (WHO) have avoided setting standards for plate counts possibly for the lack of pathogenicity and great variation in density, encountered (Dezuane, 1990). A recommended MCL for human drinking water has not yet been proposed, but the USEPA does recognize the water quality deterioration implied by high plate counts. The upper limit for portable water is usually 500cfu/ml. Dezuane (1990) says that water with counts under 100cfu/ml should be considered “potable” and values 100-500/ml “questionable”.

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Therefore the sachet water samples have potable water quality. Though earlier investigations conducted on the safety of drinking water has shown that the quality of some factory bagged sachet and hand-filled/hand-tied polythene-bagged drinking water was noted to be doubtful (Obiri-Danso et al., 2003). This observation was based on studies carried out on water samples to ascertain the presence of heterotrophic bacteria, indicators of faecal contamination (total coliforms, faecal coliforms and enterococci).

Several factors potentially might have accounted for this observation, notable among these are; improper processing and purification procedures, unhygienic handling after production, the small size of the pathogens which enable them to escape filtration and the resistance of these pathogens to physical water treatment agents and disinfectants (Cotte et al., 1999).

The presence of Salmonella typhi in the samples might be due to contamination from handlers and sellers of the sachet waters. Salmonella typhi is responsible for two types of salmonellosis: (1) Typhoid fever; (2) gastroenteritis (Le Minor, 2003).

Table 2: Morphological and Biochemical Reactions of Bacteria Isolates

<table>
<thead>
<tr>
<th>GROWTH MORPHOLOGY</th>
<th>BOICHEMICAL TESTS</th>
<th>SUGARS</th>
<th>PROBABLE ISOLATED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SHAPE</td>
<td>GRAM</td>
<td>MOILITY</td>
</tr>
<tr>
<td>2 Milkish coloured, round edge convex colonies</td>
<td>Rod -ve</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>3 Smooth colourless circular colonies, which is opaque with the entire margin</td>
<td>Rod -ve</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>9 Large round thick opaque colonies with dull irregular edges</td>
<td>Rod +ve</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10 Large round swarmy, fluorescent colonies with irregular edges</td>
<td>Rod -ve</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

Key  + = Positive- = Negative

The association of Shigella dysenteriae with sachet water samples is implicative of possible fecal contamination. This is in agreement with the reports and works of WHO (2008). The implication of the presence of Shigella dysenteriae in samples is the risk of possible outbreak of shigellosis. This is in agreement with the report of Emch et al. (2008).

Pseudomonas aeruginosa has been isolated from many environments (Prescott et al., 2005). Furthermore, their presence in samples might be due to their exceptional ability to degrade wide

Table 3: Occurrence of bacterial isolates from sachet water samples

<table>
<thead>
<tr>
<th>Isolates / Samples</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Salmonella typhi</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Shigella dysenteriae</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Bacillus subtilis</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Present = +, Absent = -
A=Agad, B=God is able, C=Davimor, D=Linkmor, E=Mrs Ben
variety of compounds. Pseudomonas aeruginosa and Bacillus cereus have been isolated as waterborne pathogens (Ichijo et al., 2010). Bacillus subtilis has been associated with different of the environments. Its isolation from the samples might imply contamination from contaminated environment especially during storage.

CONCLUSION
Some the sachet water samples were found to be contaminated with enteric pathogens while others though contaminated by other organisms generally indicated the sachet waters from Owerri were not devoid of bacteria. Though the counts were below established standards, proper treatment of the water before packaging and sterilization of packaging materials are recommended. Post production monitoring of sachet water quality should be intensified to prevent waterborne disease outbreak.

REFERENCES


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