



ANALYSES OF THE PHYSICOCHEMICAL AND MICROBIOLOGICAL QUALITIES OF SELECTED SACHET WATER BRANDS IN AWKA, ANAMBRA STATE, NIGERIA

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ABSTRACT

This study analyzed the physicochemical and microbiological qualities of five sachet water brands that are mostly consumed in Awka. The researchers used respective meters for determination of physical parameters, an atomic absorption spectrophotometer machine for heavy metals determination and streak-plate method for the determination of microbiological parameters. The five sachet water brands that were used for the study were elicited from the respondents in Awka using a questionnaire. Averaged results of the physicochemical parameters of the selected sachet water brands showed that pH yielded 6.86, electrical conductivity yielded 0.2304 μ S/m, turbidity yielded 0.0082NTU, total dissolved solids yielded 55.62mg/l, and total suspended solids yielded 42.98mg/l. In addition, averaged results of the heavy metal parameters for the selected sachet water brands showed that lead yielded 0.0178mg/l, cadmium yielded 0.0088mg/l, copper yielded 0.0146mg/l, iron yielded 2.28mg/l, zinc yielded 1.044mg/l, chromium yielded 0.0298mg/l and cobalt yielded 1.0366mg/l. Results of the microbiological parameters showed that for total count, Aqua-Rapha yielded 11×10^5 MPN/100ml, Ben-Lovers yielded 46×10^3 MPN/100ml, Rock-Tama yielded 48×10^3 MPN/100ml, Ice-Pack yielded 99×10^2 MPN/100ml and Marvel yielded 84×10^3 MPN/100ml. The study recommended that sachet water vending machines should be properly disinfected to guard against indicator organisms entraining into them which can serve as sources of sachet water contamination.

Keywords: analyses, microbiological, physicochemical, quality, sachet water, Awka.

INTRODUCTION

Drinking water is a major issue in developing countries like Nigeria where surface and underground water serves as sources of drinking water. The quality of water is determined by its physical, chemical and microbiological characteristics. In Nigeria, packaged water is accessible as one of the most drinking water sources for about 140 million people (Agwu *et al.*, 2012). Gbadegesin and Olorunfemi (2007) posited that in Nigeria, only about sixty percent of the population has access to safe drinking water.

Encarta (2008) recorded that water forms the organic foundation for human survival and in consequence implies that if this most basic need is not met, it significantly impairs man from attaining higher safety needs, social needs, esteem needs and the highest of these needs: self-actualization. Wahab *et al.* (2012) reasoned that water as a basic requirement should meet some standards including biological parameters (such as microbial population), physical parameters and chemical parameters. Whenever the threshold for these parameters set by Nigerian Standard for Drinking Water Quality (NSDWQ) is exceeded, water is said to be unacceptable for drinking water quality.

In Awka, the main source of drinking water for her inhabitants in schools, hotels, offices, parks, hospitals, churches and the society at large is sachet water. In Awka, pipe-borne water is non-existent both in supply and delivery. The proliferation of sachet water raises the question as to the hygiene of their production as well as the regularity of the monitoring of production process by National Agency for Food, Drug, Administration and Control (NAFDAC) (Dada, 2009). According to the Anambra State Ministry of Health (2014), water-based diseases such as diarrhea and typhoid have increased in Awka over the years, 2009 to 2014. In view of this fact, there is a need to examine or analyse sachet water consumed by Awka residents with a view to determining its potability as well as their physicochemical and microbiological parameters in relation to standards such as the NSDWQ.

Therefore, this study aimed to critically analyse the physicochemical and microbiological qualities of five selected sachet water brands in Awka South local government area of Anambra State, Nigeria. The study also selected the five sachet water brands that are mostly consumed in Awka using a questionnaire. Also the paper aimed to compare the physicochemical and microbiological parameters with the Nigerian Standard for Drinking Water Quality (NSDWQ) specification for potable water. The study helped to advance knowledge on the quality of sachet water in Anambra State, with a view to ascertaining the causes, effects and risk involved in the consumption of low-quality sachet water on susceptible human populations. In essence, the paper availed information on the physicochemical and microbiological variables that make sachet water unfit for consumption by the public which is useful to the relevant state and federal parastatals for enforcement and control.

MATERIALS AND METHODS

Study Area

Awka is the capital of Anambra State in Nigeria with an estimated human population of 301,657 people. It is located between latitudes 6°13'N and 6°15'N and longitudes 7°04'E and 7°06'E. It is strategically located midway between two major areas in Northern Igboland; Onitsha and Enugu which has informed its choice as an administrative

center and as a capital base for the Anambra State government. It has an area of 159.25 hectares.

Sample Collection

The study was conducted between July 2016 and December 2016 in Awka South LGA. A total of five (5) sachet water brands were analyzed for physicochemical and microbiological parameters. One sample from each of the tested sachet water brands was selected for analyses. The selected five sachet water brands were elicited from respondents using a questionnaire. Responses were elicited from residents in Awka by adopting a purposive sampling method for the questionnaire distribution.

Physicochemical Analyses:

The researchers used a Model PHS-25 pH meter to determine pH, a Model DDS-307 Conductivity Meter to measure the conductivity, a Hanna HI 99300 TDS Meter to measure the dissolved ions content of the five sachet water samples. A Buck Model 210 VGP atomic absorption spectrophotometer (AAS) to determine the concentrations of lead, cadmium, copper, iron, zinc, chromium and cobalt for the five sachet water samples (HACH, 2013).

Microbiological Analysis:

The researchers used streak-plate method with Mac Conkey Broth agar for the determination of the total count. An Electron Microscope and JOUAN XMTD Incubator were also used in the microbiological analyses (HACH, 2013).

RESULTS

The five sachet water brands that are mostly consumed in Awka are Aqua-Rapha, Ben-Lovers, Rock-Tama, Ice-Pack and Marvel from the high, medium and low densities' areas of Awka South LGA.

Physicochemical Parameters of Selected Sachet Water Brands

In Awka, pH results for the five sachet water brands showed that: Aqua-Rapha (7.3), Ben-Lovers (7.0), Rock-Tama (7.0), Ice-Pack (6.7), Marvel (6.3). Electrical conductivity (EC) results for the five sachet water brands showed that: Aqua-Rapha (0.196 μ S/m), Ben-Lovers (0.24 μ S/m), Rock-Tama (0.29 μ S/m), Ice-Pack (0.146 μ S/m), Marvel

(0.28 μ S/m). Turbidity results for the five sachet water brands showed that: Aqua-Rapha (0.005NTU), Ben-Lovers (0.016 NTU), Rock-Tama (0.003 NTU), Ice-Pack (0.004 NTU), Marvel (0.013 NTU). Total Dissolved Solids (TDS) results for the five sachet water showed that: Aqua-Rapha (24.6mg/l), Ben-Lovers (30.0mg/l), Rock-Tama (91.4mg/l), Ice-Pack (60.1mg/l), Marvel (72.0mg/l). Total Suspended Solids (TSS) results showed that: Aqua-Rapha (19.6mg/l), Ben-Lovers (22.4mg/l), Rock-Tama (63.2mg/l), Ice-Pack (46.3mg/l), and Marvel (63.4mg/l).

Heavy Metals of Selected Sachet Water Brands

In Awka, results for sachet water brands for lead (Pb) heavy metal showed that: Aqua-Rapha (trace), Ben-Lovers (0.016mg/l), Rock-Tama (0.020mg/l), Ice-Pack (0.044mg/l), Marvel (0.009mg/l). Results for sachet water brands for cadmium (Cd) heavy metal showed that: Aqua-Rapha (0.002mg/l), Ben-Lovers (0.014mg/l), Rock-Tama (0.009mg/l), Ice-Pack (0.008mg/l), Marvel (0.011mg/l). Results for sachet water brands for Copper (Cu) heavy metal showed that: Aqua-Rapha (0.016mg/l), Ben-Lovers

(0.008mg/l), Rock-Tama (0.023mg/l), Ice-Pack (0.007mg/l), Marvel (0.019mg/l). Results for sachet water brands for Iron (Fe) heavy metal showed that: Aqua-Rapha (1.66mg/l), Ben-Lovers (2.56mg/l), Rock-Tama (2.4mg/l), Ice-Pack (1.23mg/l), Marvel (3.55mg/l). Results for sachet water brands for zinc (Zn) heavy metal showed that: Aqua-Rapha (0.48mg/l), Ben-Lovers (0.98mg/l), Rock-Tama (1.46mg/l), Ice-Pack (0.85mg/l), Marvel (1.45mg/l). Results for sachet water brands for chromium (Cr) heavy metal showed that: Aqua-Rapha (0.025mg/l), Ben-Lovers (0.029mg/l), Rock-Tama (0.048mg/l), Ice-Pack (0.014mg/l), Marvel (0.033mg/l). Results for sachet water brands for cobalt (Co) heavy metal showed that: Aqua-Rapha (1.120mg/l), Ben-Lovers (1.115mg/l), Rock-Tama (0.83mg/l), Ice-Pack (0.98mg/l), Marvel (1.138mg/l).

Microbiological Parameters of Selected Sachet Water Brands

The microbiological parameters of the five sachet water brands that are mostly consumed in Awka are given in Table 1 below:

Table 1: Microbiological Parameters of Selected Sachet Water Brands in Awka

S/N	Brands	Dilution Factor	Total Count (MPN/100ml)	Microbial Isolates
1	Aqua-Rapha	10 ⁻⁶	11 x 10 ⁵	<i>Pseudomonas aeruginosa, Klebsiella spp.</i>
2	Ben-Lovers	10 ⁻⁵	46 x 10 ³	<i>Escherichia coli, Streptococcus faecalis, Klebsiella spp.</i>
3	Rock-Tama	10 ⁻⁶	48 x 10 ³	<i>Klebsiella spp, Escherichia coli, Pseudomonas aeruginosa</i>
4	Ice Pack	10 ⁻⁷	99 x 10 ²	<i>Streptococcus faecalis, Klebsiella spp, Escherichia coli.</i>
5	Marvel	10 ⁻⁷	84 x 10 ³	<i>Pseudomonas aeruginosa, Escherichia coli, Klebsiella spp.</i>

DISCUSSION

Discussion of Findings on the Physicochemical and Microbiological Parameters

This work partly seeks to compare the laboratory values of the physicochemical parameters obtained from the sampled sachet water brands in Awka with the Nigerian Standard for Drinking Water Quality (NSDWQ). The pH maximum permitted value of NSDWQ is 6.5 to 8.5 and the pH laboratory values

for five sachet water brands in Awka are lower or within the NSDWQ standard making them acceptable for drinking water quality. This is consistent with the works of kerketta *et al.* (2013) and Nkansah *et al.* (2010). The NSDWQ maximum permitted limit for EC is 10 μ S/m and the EC laboratory values obtained for the five sachet water brands in Awka are below the standard making them acceptable for drinking water quality. This is

consistent with the works of Cheabu & Ephraim (2014) and Ekhaise & Anyasi (2005). For Turbidity, the NSDWQ permissible limit is 5.0 NTU and the turbidity laboratory values obtained from the five sachet water brands are all below the standard making them acceptable for drinking water quality. For Total Dissolved Solids (TDS), the NSDWQ maximum permissible limit is 500mg/l and the TDS laboratory values obtained from the five sachet water brands are all below the standard making them acceptable for drinking water quality. This is consistent with the works of Cheabu & Ephraim (2014) and Adekoyi & Salako (2012). Averaged results of the five sachet water brands in Awka showed that TSS yielded 42.9mg/l. This is consistent with the works of Belay & Sahil (2013) and Onwughara *et al.* (2013).

For the heavy metal parameters, NSDWQ maximum permissible limits for copper is 1.0mg/l and the laboratory values for the five sachet water brands are lower than the standard making them acceptable for drinking water quality. This is consistent with the works of Faiz *et al.* (2009) and Irenosen *et al.* (2014). For iron, NSDWQ maximum permissible limit is 0.3mg/l and the laboratory values for the five sachet water brands are higher than the standard making them unacceptable for drinking water quality. For zinc, NSDWQ maximum permissible limit is 5.0mg/l and the laboratory values of all the five sachet water brands are below the standard making them acceptable for drinking water quality. This is consistent with the works of Olayinka (2010) and Achadu *et al.* (2013). Averaged result for cadmium for the five sachet water brands in Awka yielded 0.0088mg/l and this is consistent with the works of Faiz *et al.* (2009) and Mthembu *et al.* (2011). Averaged result for lead for the five sachet water brands in Awka yielded 0.0178mg/l and this is consistent with the work of Irenosen *et al.* (2014).

From Table 1 (above) in Section 1.3.3, total count for Aqua-Rapha yielded 11×10^5 MPN/100ml. Total count for Ben-Lovers yielded 46×10^3 MPN/100ml. Total count for Rock-Tama yielded 48×10^3 MPN/100ml and this is consistent with Mustafa *et al.* (2013). Total count for Ice-Pack yielded $99 \times$

10^2 MPN/100ml. Total count for Marvel yielded 84×10^3 MPN/100ml.

Also from Table 1 in Section 1.3.3, there is presence of indicator organisms such as *Pseudomonas aeruginosa*, and *Klebsiella spp.* Presence of indicator organisms in drinking water indicates the probable presence of disease-causing microorganisms in water. *Pseudomonas aeruginosa* can cause infections in the blood, lungs while *Klebsiella spp* can cause pneumonia, sepsis, wound infections and urinary tract infections. Even more health-threatening is the presence of fecal indicators such as *Streptococcus faecalis* and *Escherichia coli*, which are major causes of diseases which are harmful to the human body. Fecal indicators are introduced into the environment (of which water is a part) through fecal matter as they are responsible for diseases such as diarrhea, fever and pains. This work postulated that the sachet water ingested by Awka inhabitants may be responsible for water-related diseases such as diarrhea and these microbial isolates present in the tested sachet water brands confirm that.

For the microbiological parameters, NSDWQ maximum permitted level for all microorganisms is NIL. This means a greater than zero level is not acceptable. The microbial isolates and total count (TC) values obtained in the five sachet water brands that are mostly consumed in Awka are all above the zero level making the values not accepted for the standard of potable drinking water.

CONCLUSION

In line with the objectives of this study, there is presence of pH, conductivity, turbidity and total solids contents which were not significant relative to their standard regulatory values in tested sachet water brands in Awka. Also, there is presence of heavy metals in tested sachet water brands. These physicochemical contents were present in all the sachet water tested in this study. From the study carried out, there is presence of indicator organisms in sachet water brands in Awka which is responsible for morbidity of diseases such as typhoid and diarrhea in susceptible human populations in Awka.

Recommendations

The following were recommended for this study:

- i. Sachet water vending machines should be properly disinfected to guard against indicator organisms entraining into them which can serve as sources of sachet water contamination.
- ii. Physicochemical and microbiological qualities of sachet water brands should be in line with NSDWQ standard.
- iii. Total coliform microbes and indicator organisms should be hygienically removed from sachet water production processes.
- iv. Sachet water regulatory agency (NAFDAC) should ensure that sachet water brands are

produced in hygienically-sound environment.

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