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Physicochemical and bacteriological analysis of the quality of sachet water and their source point (spring box) consumed in Bo city, Sierra Leone

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This study was conducted to assess the physical, chemical, and bacteriological parameters of five-brand of sachet water, and their source point consumed in Bo city, southern Sierra Leone. The physical parameters include: pH, temperature, turbidity, total dissolved solid, and conductivity; chemical parameters include: Residual Chlorine, Magnesium, Potassium, Nitrite, Ammonia; and bacteriological parameters include: Escherichia coli, fecal coliform, and non-fecal coliform. Samples were collected and conveyed to the laboratory within 30 min. The result analyzed shows that the physical, chemical and bacteriological parameters of the Spring Box, and the five-brand were in conformity with the World Health Organization (WHO) guidelines. However, the pH of four-brand and the Spring Box fell below WHO standards (6.50-8.50), only Tee Spring had a pH which is within the permissible limit. The temperature of the Spring Box, and the five-Brand fell above the WHO standard (25.00°C). It can be said that the physical, chemical, and bacteriological parameters of all the five-brand and the Spring Box, are all within the WHO guidelines limit, and therefore fit for drinking.

Key words: pH, WHO, brands, sachet, parameter.

INTRODUCTION

One of the major and critical problems in most developing countries today is the provision of an adequate and safe drinking water to its populace (Kulshershtha, 1998). A reliable supply of clean wholesome water is highly essential in a bid to promote healthy living among the inhabitants of a defined geological region in addition to being key to sustainable development, health, food production and poverty reduction (Balogun et al., 2014). It is estimated that 2.2 billion people currently do not have access to safely managed drinking water, and that water use has increased sixfold over the past century, and is rising by about 1% a year (UN World Water Development Report, 2020).

Established by law in 1988, the Sierra Leone Water Company (SALWACO) is the company responsible for water supply in the entire country except the capital.

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The Guma Valley Water Company (GVWC) is responsible for water supply in Greater Freetown. The Sierra Leone civil war that started in March, 1991 and finally ended in 2002 was a tremendous setback for the country, where major infrastructures and water points were destroyed beyond repaired. Immediately after the war there was urgent need for clean and potable water by Sierra Leonean populaces both at national and district levels. As a means of solving the problem of accessibility of drinking water, in 2004, the Local Government Act came into existence, where water supply to the then 12 districts were devolved to local authorities. This situation further widened the already deteriorated services, as a result of inadequate resources generated at districts level. At the end of 2004, the United Nation Development Program ranked Sierra Leone as the world second poorest nation. The rate of poverty was so high that affected all facet of society including the access to clean and safe water.

At present, access to safe drinking water is estimated to be limited to 22% of the population in Sierra Leone (25% in Bo district) (Donkor et al., 2007).

In Bo, Sierra Leone, only about one in four households has access to improved drinking water sources (Ansumana et al., 2013; Jacobsen et al., 2012). World Health Organization (WHO, 2016) report stated that, “Almost half of the population of Sierra Leone has no access to safe drinking water and only 13% of the population has access to improved non-shared sanitation facilities.

The major wellhead of drinking water in Bo city, and its immediate environs are boreholes, wells, hand pump, tap water (in specific quarters) and traditional sources such as spring box and swamp water. People who do not have access to a reliably safe drinking water source in or near the home must rely on commercial drinking water products (Maduka et al., 2014).

The quest for cheap and readily available source of potable water has led to the emergence of sachet water (Anyamene and Ojiagu, 2014) which is a locally sourced low-cost alternative drinking water scheme providing sustainable access to safe water in rural and semi urban settings of developing nations (USEPA, 2012; Balogun et al., 2014). Consequently, sachet water has gradually become the most consumed liquid for both the rich and poor (Akinde et al., 2011). Sachet water is any machine treated water that is filled (250 ml) in a special plastic grain (sachet) and ceased by the application of machine, and sold to the consumer for consumption.

Current trends however unfortunately suggest that sachet water could be a route of transmission of enteric pathogens which raises issues of the problem of its purity and health concern (Oladapo et al., 2009; Mgbakor et al., 2011; Akinde et al., 2011; Isikwue and Chikezie, 2014).

The commercial drinking water market is not effectively regulated, so the quality of these products is quite variable, as reported in Ghana (Adetunde et al., 2014; Oyelude and Ahenkorah, 2012), Nigeria (Anyamene and Ojiagu, 2014; Falegan et al., 2014; Isikwue and Chikezie, 2014; Thliza et al., 2015), and India (Gangil et al., 2013). Contaminated water and poor sanitation are linked to transmission of diseases such as cholera, diarrhea, dysentery, hepatitis A, typhoid, and polio (WHO, 1993).

This study will serve as a tool to examine, the physical, chemical and bacteriological properties of five-brand of sachet water manufactured, and their source point in Bo city, southern Sierra Leone, and hence find a solution to help improve the quality of these sachets water, and also ensured that sachet water manufacturers comply with the standard that is being set out by the WHO guidelines.

MATERIALS AND METHODS

Description of study area

Bo city, is the provincial headquarter of the southern region, and it is the second largest city after Freetown. It is located -7.96 latitude and -11.74 longitude, and it is situated at elevation 104 m above sea level. Bo city had a population of about 233,684 (SSL Census, 2017), making it the second biggest city in southern province. It is situated approximately 155 miles (250 km), southeast of Freetown. It has an area of 1500 square miles (approximately 3885 km^2), and the city is divided into three wards, namely, North, East and West (Figure 1).

Description of sample area

The Spring Box (source point) used to collect samples for this study is situated at Kortugbuma Section in Bo city. Kortugbuma is separated from government reservation by a bridge. Kortugbuma is a densely populated area, and it is connected to the central business district (CBD) in the west end of Bo city. It shares boundary with Baima Road, Hospital Road, and Lion Road and Mariama lane. Kortugbuma Spring Box (water source) is used both by the general public and private investors (Figure 2).

Sampling

250 ml each of the five-brand (Spring Box, Tee Spring, Kuma, Save Life, Blue Diamond, and Jah) sold at retail point, and 250 ml water from the Spring Box (source point) was conveyed to the laboratory (Directorate of water resources, in the Ministry of Water Resources at their regional head office in Bo City) within 30 min of collection time for analyses.

A sterilized scissors was used to carefully cut the edge of each sachet to be tested and the sample carefully placed in a sterilized beaker. A sterilized cup was used to obtained 250 ml sample from the Spring Box (source point) and placed in a sterile beaker. The samples were then subjected to physical, chemical, and bacteriological analyses within two days.

Sample collection and analysis

Physical parameters

Temperature: A digital temperature with electrode was sterilized, and the beaker rinsed three times with distilled water. The edge of the sachet water was cut by a sterilized scissor. 250 ml of water

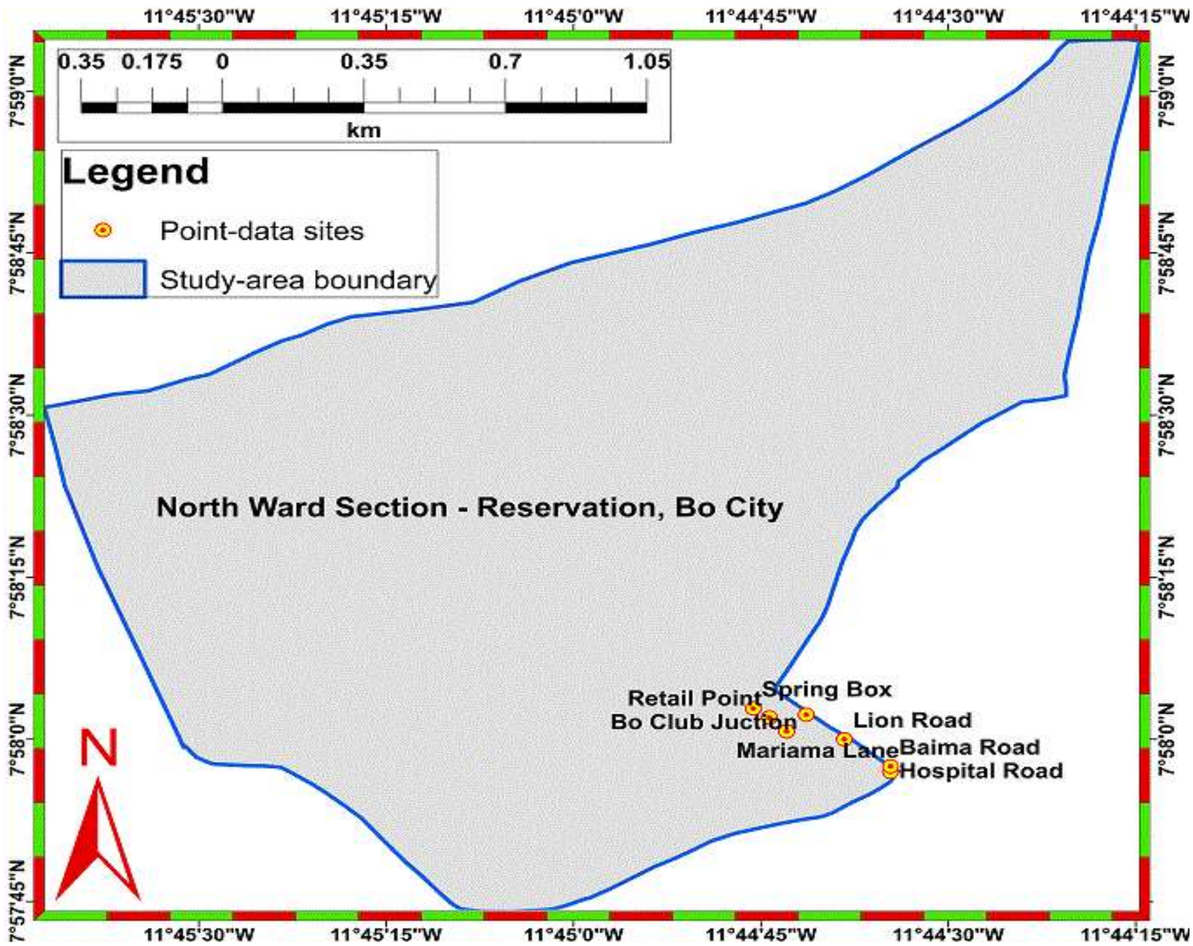

Figure 1. Map of Bo city showing the study area.

Figure 2. Spring Box where the water sample for the Spring was collected.

duplicates and average mean recorded. The electrode was wiped with a tissue paper before being used in another sample. Temperature was recorded in Celsius (°C).

pH: A digital pH meter with electrode was sterilized, and a beaker rinsed three times with distilled water. The edge of the sachet water was cut by a sterilized scissor. 250 ml of water sample was poured into the sterilized beaker, the button switched on, the pH was taking in duplicates and average value recorded for each sample. The electrode was wiped with tissue paper before being used in another sample.

Conductivity: A conductivity meter with electrode was sterilized, and the beaker rinsed three times with distilled water. The edge of the sachet water was cut by a sterilized scissor. 250 ml of water sample was poured into the sterilized beaker, and the electrode inserted into it. Duplicate values were taken and average mean value recorded in micro-Siemen per centimeter (µS/cm).

Total dissolved solids (TDS): A conductivity/TDS with probe was sterilized, and a beaker rinsed three times with distilled water. The edge of the sachet water was cut by a sterilized scissor. 250 ml of water sample was poured in the sterilized beaker, and electrode switched on, the sample was stirred by a stirrer to ensured uniform mixture. Duplicate values were read and recorded in mg/L.

Turbidity: A Photometer 7100, was sterilized and calibrated. A sterilized conical flask was used to prepare a blank which was used for proper calibration and as reference point. A sample of water was filled in a clean dry cuvette test tube and then covered with light black shield cap. Duplicate values were read and recorded in nephelometric turbidity unit (NTU).

Chemical parameters

Chemical analysis is done by the use of WAGTECH PHOTOMETER 7100. Each chemical is analyzed by the use of procedure outlined in the wagtech manual. Each chemical have different method of analysis.

Ammonia concentration: A blank (10 mL) sample was prepared as reference (0.00 mg/L). A test tube was rinsed three times with distilled water, and filled to the 10 ml mark with water sample. One tablet each of Ammonia No.1 and No.2 were added, using a sterilized stirrer, the tablets was crushed and stirred to dissolve completely. The mixture was allowed to stand for 10 min for color to be visible. It was inserted into the cell holder and lid closed. The concentration of ammonia was read and recorded in mg/L.

Nitrite concentration: A carefully blank (10 ml) sample was prepared as reference (0.00 mg/L). Using a digital Spectrophotometer, one tablet of Nitrite was added to a sterilized test tube, crushed using a stirrer, and stirred to dissolved in 10 ml mark of water sample and allow to stand for 10 min, and it was inserted into the cell holder and lid closed. Using appropriate wave length, the concentration of nitrite was read and recorded in mg/L.

Potassium: A carefully prepared blank (10 mL) sample was produced as reference (0.00 mg/L). A test tube was rinsed three times with distilled water. One tablet of potassium was added to 10 ml mark, a stirrer was used to crushed and stirred to dissolved. The mixture was allowed to stand for 10 min for full color development and inserted into the chamber, using a calibrated digital photometer, the values were recorded in mg/L.

Residual chlorine (RC): Using digital photometer (model 5000). A carefully prepared blank (10 mL) sample was produced as reference (0.00 mg/L). A test tube was rinsed three times. One tablet of chlorine was added to 10 ml mark, crushed and stirred to dissolved, and allowed to stand for some minutes for full color development and inserted into the chamber, the values were read and recorded in mg/L.

Magnesium: A carefully prepared blank (10 mL) sample was produced as reference (0.00 mg/L). A test tube was rinsed three times with distilled water. One tablet of magnesium was added to 10 ml mark, crushed and stirred to dissolved. The mixture was allowed to stand for 10 min for full color development and inserted into the chamber, using a calibrated digital photometer, the values were recorded in mg/L.

Bacteriological parameters

Escherichia coli, faecal coliform, and total coliform count

A sample of water collected from the retail point, and the Spring Box (source point), was immediately conveyed to the laboratory for analysis of *E. coli*, faecal coliform, and total coliform. Coliform bacteria describe a group of enteric bacteria that includes *E. coli*, *Klebsiella* species and *Enterobacter* species (Adomako et al., 2008).

They are Gram negative, facultative anaerobes and non-sporing rods that may be motile or not which ferments lactose with the production of acid and gas when incubated at 37°C (Edberg et al., 2000). Almost all the methods used to detect total coliforms, fecal coliforms and *E. coli* are enumeration methods that are based on lactose fermentation (American Public Health Association, 1992).

The culture media was first prepared; a sample of water was boiled for 10 min, and allowed to cool. Ten spoonful of culture media was added into the sterilized measuring tube using the integral spatula. The cooled sterilized water was added to the media in the measuring tube to the 20 ml mark. The measuring tube was closed with lid, and then shaken to dissolve all the powder, the colour of the culture media then turned bright pink colour. The media measuring device was then sterilized at 121°C for at least 10 min.

WHO standard for faecal coliform is 0 count/100 ml. A membrane filter technique was used for microbial coliform analysis, each sample was filtered through a filter membrane with a uniform pore of 0.45 µm. The bacteria were retained on the surface of the membrane filter. The membrane was placed in a Petri dish containing “m-Faecal coliform broth (PARK Scientific Limited)” and was incubated at 44°C for 18 to 24 h. The bacterial colonies were then counted using magnifying lens and expressed as numbers per 100mls of water.

Estimated bacteria present/250 ml of water sample=Number of colony forming units/Volume of sample water filtered ×100

RESULTS AND DISCUSSION

Physical parameters

pH

From Table 1, the mean pH recorded for the Spring Box (5.88) and the four-brand (Kuma 5.84, Blue Diamond 5.30, Safe Life 5.57, and Jah 5.73), fell outside the WHO guidelines (6.50 - 8.50). Except Tee Spring (6.50) that recorded the mean pH that is within the WHO limits. The reason for the low values in pH of the Spring Box and the four-brand, could be associated with the presence

Table 1. The physicochemical and bacteriological mean values obtained for both the Spring Box and the five-brand.

pH		Temperature (°C)	Conductivity (µS/cm)	Total dissolved solid (mg/L)	Turbidity (NTU)	Residual chlorine (mg/L)	Potassium (mg/L)	Nitrite (mg/L)	Ammonia (mg/L)	Magnesium (mg/L)	*Escherichia coli* (E. Coli)	Faecal coliform	Non-faecal coliform	Brands
April	5.86	29.80	98.70	49.20	0.00	0.00	4.60	0.13	0.00	5.00	0.00	0.00	0.00	
May	5.88	29.82	98.80	49.40	0.00	0.00	4.61	0.14	0.00	5.01	0.00	0.00	0.00	Spring Box
June	5.90	29.83	98.90	49.60	0.00	0.00	4.62	0.15	0.00	5.02	0.00	0.00	0.00	
Mean	5.88	29.82	98.80	49.40	0.00	0.00	4.61	0.14	0.00	5.01	0.00	0.00	0.00	
April	6.49	29.60	109.90	55.39	0.00	0.00	3.70	0.05	0.00	6.00	0.00	0.00	0.00	
May	6.50	29.61	109.91	55.40	0.00	0.00	3.72	0.06	0.00	6.02	0.00	0.00	0.00	Tee Spring Pure water
June	6.51	29.62	109.92	55.41	0.00	0.00	3.73	0.07	0.00	6.03	0.00	0.00	0.00	
Mean	6.50	29.61	109.91	55.40	0.00	0.00	3.72	0.06	0.00	6.02	0.00	0.00	0.00	
April	5.83	29.80	99.30	49.40	0.00	0.00	3.30	0.09	0.00	7.00	0.00	0.00	0.00	
May	5.84	29.81	99.32	49.41	0.00	0.00	3.32	0.10	0.00	7.01	0.00	0.00	0.00	Kuma Pure water
June	5.85	29.82	99.34	49.42	0.00	0.00	3.34	0.11	0.00	7.02	0.00	0.00	0.00	
Mean	5.84	29.81	99.32	49.41	0.00	0.00	3.32	0.10	0.00	7.01	0.00	0.00	0.00	
April	5.57	29.90	105.60	53.00	0.00	0.00	3.30	0.06	0.00	4.00	0.00	0.00	0.00	
May	5.57	29.92	105.61	53.01	0.00	0.00	3.31	0.07	0.00	4.02	0.00	0.00	0.00	Safe Life Pure water
June	5.58	29.93	105.62	53.02	0.00	0.00	3.32	0.08	0.00	4.04	0.00	0.00	0.00	
Mean	5.57	29.92	105.61	53.01	0.00	0.00	3.31	0.07	0.00	4.02	0.00	0.00	0.00	
April	5.29	29.80	99.90	49.80	0.00	0.04	3.10	0.09	0.00	9.00	0.00	0.00	0.00	
May	5.30	29.81	99.90	49.82	0.00	0.05	3.11	0.10	0.00	9.01	0.00	0.00	0.00	Blue Diamond Pure water
June	5.31	29.82	99.91	49.84	0.00	0.07	3.12	0.11	0.00	9.03	0.00	0.00	0.00	
Mean	5.30	29.81	99.90	49.82	0.00	0.05	3.11	0.10	0.00	9.01	0.00	0.00	0.00	
April	5.72	29.70	104.00	52.10	0.00	0.00	3.30	0.09	0.00	9.00	0.00	0.00	0.00	
May	5.73	29.71	104.01	52.12	0.00	0.00	3.32	0.10	0.00	9.02	0.00	0.00	0.00	Jah Pure water
June	5.74	29.72	104.02	52.13	0.00	0.00	3.34	0.12	0.00	9.04	0.00	0.00	0.00	
Mean	5.73	29.71	104.01	52.12	0.00	0.00	3.32	0.10	0.00	9.02	0.00	0.00	0.00	

of carbon dioxide. Carbon dioxide from the atmosphere dissolves into the water bodies as dissolved CO_2, and some of it reacts with the water to form carbonic acid. Some of these extra carbonic acid molecules react with a water molecule to give bicarbonate ion and hydronium ion which increases the acidity of the water, thereby resulting in a low pH value.

A similar study conducted on the quality of residential drinking wells in Bo city shown similar trend to those observed in this study (Jimmy et al., 2012). Another study was also conducted in sachet drinking water in a campus in Imo State, Nigeria. Where five of the brands of sachet drinking water had their pH values lower than the permissible limit, ranging from 5.21 to 5.93, only one (hephzzy) sachet water brand had pH valued within the permissible limit (Okechukwu et al., 2015). Acidic water has also been recorded in other parts of Africa, including Guinea-Bissau (Bordalo and Savva-Bordalo, 2007; Haruna et al, 2005); Ghana (Adomako et al, 2014; Fianko, 2010a, 2010b); Nigeria (Nduka and Orisakwe, 2011; Omezuruike, 2008), South Africa (Zamxaka, 2004); and Tanzania (Shayo et al, 2007).

Although pH has been found to have no direct impact on sachet water consumers (no health- based guideline recommended for pH value WHO, 2003). Careful examination of pH control is necessary at all levels of water treatment to ensure disinfection and clarification, and also to minimize low pH of water entering water producing machines in other to help control or minimize corrosion of pipes.

Temperature of water

The mean temperature recorded in Table 1, for both the Spring Box (29.82°C), and the five-brand (Tee Spring 29.61°C, Kuma 29.810°C, Safe life 29.92°C, Blue Diamond 29.81°C, Jah 29.71°C), fell outside the WHO limits which is 25°C at the pH of 7. The lowest temperature was recorded in Tee Spring. WHO guideline states that drinking water temperature should not exceed 25°C. Temperature has a direct link with pH, the lower the pH the higher the temperature of water. Increase or decrease in temperature could be associated with weather, the depth of installation of the system, the soil nature, ground water level, and the presence of anthropogenic heat material. Temperature played a major role in water quality analysis, since it influences both the physicochemical and bacteriological processes, such as absorption of chemicals and microbial growth.

Conductivity

The mean conductivity values recorded in Table 1, for both the Spring Box (98.80 s/cm), and the five brands (Tee Spring 109.91, Kuma 99.32, Safe Life 105.61, Blue Diamond 99.90, and Jah 104.01 s/cm) fell below the WHO recommended value which is <450 (s/cm). The lowest conductivity value was recorded by the Spring Box. The low values in conductivity could be associated with the cooler nature of the water at the time of taking the reading at the source point. Conductivity values are influence by temperature (the cooler the water the lower the conductivity, and the warmer the water, the higher the conductivity value).

From Table 1, the turbidity values recorded for the Spring Box (0.00 NTU), and the five brands (Tee Spring 0.00 NTU, Kuma 0.00 NTU, Safe Life 0.00 NTU, Blue Diamond 0.00 NTU, and Jah 0.00 NTU), fell below the WHO guideline limits, which is turbidity (NTU). The low values in turbidity could be as a result of Ultrafiltration Systems. Ultrafiltration pushed water through a semipermeable membrane, and removed any contaminants but retained minerals in the water, while filtering out bacteria, viruses and parasite. In ultrafiltration system (0.01-0.05 microns or less for UF; USEPA, 2005), suspended particles that are too large pass through the membrane stick to the outer membrane surface. This system has helped to reduce the degree of turbidity in water sample. Material that makes water to be turbid include suspend clay, silt, inconspicuous inorganic and organic matter, algae, and other microscopic particles.

From Table 1, the total dissolved solid in the Spring Box (49.40 mg/L) and the five brands (Tee Spring 55.40, Kuma 49.41, Safe Life 53.01, Blue Diamond 49.82, and Jah 52.12 mg/L) fell below the WHO guideline limits (TDS 500 mg/L). The low values in Total Dissolved Solid could be as a result of proper membrane filtration techniques which filter both organic and inorganic substance contained in the water sample. Large amount in TDS can increase the degree of turbidity and sediment in water. For potable water, Environmental Protection Agency recommends 500 mg/L. When TDS level exceed 1000 mg/L, it is considered unfit for drinking (EPA).

Chemical parameters

From Table 1, the residual chlorine content in the Spring Box (0.00 mg/l), and four of the brands (Tee Spring 0.00 mg/L, Kuma 0.00 mg/L, Safe Life 0.00 mg/L, and Jah 0.00 mg/L) show no presence of residual chlorine in the water sample. It is only Blue Diamond (0.05 mg/L), that recorded a detectable amount of residual chlorine but fell below the WHO guideline limits which is 0.3 to 0.5 mg/l after 30 min disinfection. The lack of detectable value of residual chorine in the water sample could be as a result of disinfecting the water with chlorine. The fundamental reason of adding chlorine to water is to destroy bacteria, and viruses that can enter water treatment channel in different forms. According to a report from the U.S. Council of Environmental Quality, the cancer risk for people who drink chlorinated water is up to 93% higher than for those whose water does not contain chlorine.

From Table 1, the potassium concentration in the Spring Box (4.61 mg/L) and the five-brand (Tee Spring 3.72 mg/L, Kuma 3.32 mg/L, Safe life 3.31 mg/L, Blue Diamond 3.11 mg/L, and Jah 3.32 mg/L), show low potassium level in the water samples. There is no established guideline value for potassium in drinking-water, because it occurs in drinking-water at concentrations well below those of health concern (WHO, 2009). The recommended daily requirement is greater than 3000 mg principal reference (WHO, 2009) potassium in drinking water. Currently, there is no evidence that potassium levels in municipally treated drinking-water, even water treated with potassium permanganate, are likely to pose any risk for the health of consumers, because it occurs in water far below the estimated amount (WHO, 2009). Potassium can also occur in drinking-water as a consequence of the use of potassium permanganate as an oxidant in water treatment. Although potassium may cause some health effects in susceptible individuals, potassium intake from drinking-water is well below the level at which adverse health effects may occur (WHO, 2009).

From Table 1, the nitrite content in the Spring box (0.14 mg/L), and the five-brand (Tee Spring 0.06 mg/L, Kuma 0.10 mg/L, Safe Life 0.07 mg/L, Blue Diamond 0.10 mg/L, Jah 0.10 mg/L), fell below the WHO standard limit which is >3. The average mean value for the five-brand (0.09 mg/L) is lower than that of the Spring Box (0.14). The low values in the nitrite level are as a result of the quantity of nitrite entering into fresh water through runoffs, from farms that used fertilizer enriched soils, sewage and erosion of natural crop, decay plant and animal waste transported by rain or irrigation channels. These are some of the major ways through which nitrite enter into water.

Nitrite may cause health problems if present in public or private water supplies in amounts greater than the drinking water standard set by Environment Protection Agency.

Children below six months who drink water containing nitrite in excess of the maximum contaminant level (MCL) could become seriously ill and, if unattended to, may die. Symptoms include shortness of breath and blue baby syndrome.

From Table 1, the ammonia concentration in the Spring Box (0.00 mg/L), and the five-brand (Tee Spring 0.00 mg/L, Kuma 0.00 mg/L, Safe Life 0.00 mg/L, Blue Diamond 0.00 mg/L, and Jah 0.00 mg/L), fell below the WHO standard limits. The guideline value set for ammonia in drinking water is 1.5 mg/L (WHO, 2007). The absence of ammonia in the water sample might have resulted from the lack of disinfecting the water with chloramines.

According to WHO (2003), principal reference material, ammonia may be present in drinking-water as a result of disinfecting the water with chloramines. Another major source of ammonia entering surface water and groundwater are domestic sewage and industrial effluent (WHO, 2003).

From Table 1, the Magnesium concentration in the Spring Box (5.01 mg/L) and the five-brand (Tee Spring 6.02 mg/L, Kuma 7.01 mg/L, Safe Life 4.02 mg/L, Blue Diamond 9.01 mg/L, and Jah 9.02 mg/L), fell below the WHO standard. According to WHO (2003), the maximum permissible limit of Magnesium in drinking water is <30 mg/L.

The average mean of the five-brand (7.02 mg/L) is higher than that of the Spring Box (5.01 mg/L). Magnesium entered water as water sweep passed soil and rock which dissolved minerals. Calcium and magnesium dissolved in water are the two common minerals responsible for hardness of water. There is no evidence of health effect associated with sachet consumer drinking magnesium water (WHO, 2003). Studies have revealed that water rich in Magnesium can help lower risk of cardiovascular disease.

Bacteriological parameter

From Table 1, the mean value recorded, for *E. coli* (0.00), faecal coliform (0.00), and total coliform (0.00) for the Spring Box and the five-brand showed no presence of microbial bacteria.

The lack of microbial particles in the water sample could be associated with proper membrane filter technique, in connection with different water purification methods such as pre-chlorination, aeration, coagulation, sedimentation, filtration, desalination and disinfection. Almost all the methods used to detect total coliforms, fecal coliforms and *E. coli* are enumeration methods that are based on lactose fermentation (American Public Health Association, 1992). According to the WHO standards, 1997, potable water for human consumption must be free of microbial indicators of faecal contamination and the coliform count per 100 ml of drinking water must be zero. WHO (2004) states that a zero *E. coli* count per 100 ml of water sample is classified as “excellent” and belong to category ‘A’. Bacteria counts of 1-10 per 100 ml belong to category ‘B’ and are classified as “acceptable”. Bacteria counts of 10-50/100 ml belong to category ‘C’ and unacceptable. Finally, counts greater than 50/100 ml belong to category ‘D’ and grossly polluted.

Conclusion

Sachet water play a pivoted role in providing potable, accessible, and good quality drinking water to the inhabitant of Bo city, and its immediate surroundings. However, the maintenance of these sachets water and its hygienic sustainability must be a concern to all citizens irrespective of your location and region.

From this study, it can be concluded that the water from the Spring Box, and four of the brands (Kuma, Safe Life, Blue Diamond, and Jah Water) analyzed showed low pH values. A high temperature value was also recorded for both the Spring Box, and all the five-brand, which exceed the WHO guideline limit of 25°C.

From the analysis, it can be concluded that the physical, chemical and bacteriological parameters of both the Spring Box and the finished product (the five-brand), all met the recommendation standards set out by the WHO for potable drinking water, and it is therefore fit for drinking.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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