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Full Length Research Article

EFFECTS OF STORAGE ON THE QUALITY OF SELECTED SACHET WATER PRODUCED WITHIN SABON GARI LOCAL GOVERNMENT AREA OF KADUNA STATE

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ABSTRACT
Water is life and every living thing depends on it for existence. Sachet water has gradually become the most widely consumed liquid in Nigeria with varying qualities. This study investigates the effects of storage on the physicochemical status and bacteriological quality of selected sachet water produced in Sabon Gari Local government area of Kaduna state. Five (5) brands of sachet water were collected within 24h of production and stored at ambient temperature. Sub samples were drawn from the stock samples for physico-chemical and microbiological analyses and on weekly basis. Physical parameters were determined by instrumental methods. Cationic and anionic constituents were determined by standard titrimetric and spectrophotometric methods. Temperature, pH, Turbidity, Total Dissolved Solids (TDS), Electrical Conductivity (EC) and Colour values ranged from (24.8 - 29.6) °C, (7.3 - 8.4), (0.36 - 0.77) NTU, (63.3 - 99.6) ppm, (131.5 - 210.5) ps/cm and (2 - 8) Pt -Co, respectively. The Total hardness, Alkalinity, Chloride, Nitrate, Fluoride, and Iron values varied from (39 - 85) mg/l, (18- 77) mg/l, (29.2 - 248.7) mg/l, (0.22 - 1.30) mg/l, (0.15 - 1.05) mg/l, and (0.00 - 0.07) mg/l and with an average coliform count of 15.4 MNP/100ml. The physico-chemical analysis indicated that the average values of the parameters of all the sachet water brands were below the Nigerian Standard for Drinking Water Quality (NSDWQ) and World Health Organization (WHO) permissible limits. Bacteriological analysis in terms of total coliform revealed that all the sachet water brands showed positive coliform count value while the biochemical test indicated contaminations with Enterobacter spp making it unfit for portability. The study advocates proper water treatment by water manufacturers and strict monitoring for compliance by the regulatory agencies to avoid water borne diseases.

Keywords: Effects, Storage, Quality, Sachet, Water.

INTRODUCTION

Most people living in the major cities of Nigeria do not have access to pipe borne water, probably due to unavailability or inadequacy of potable water (Mustapha, 2008). People, therefore, resort to the more costly alternative of buying water from vendors. Sachet or bottled water became a major source of drinking water (Omalu *et al.,* 2010). Sachet water, a brand of packaged water has, therefore, gradually become the most widely consumed liquid for both the rich and the poor in Nigeria. It is the brand of choice to everyone because it is a cheaper alternative to the bottled brand, considered to be the refreshment of the affluent. Hygiene, purity, tastes, and, most importantly, safety is probably amongst various reasons for sachet water consumption. Unfortunately, the problems of its purity and health concerns have begun to manifest (Oladipo *et al,* 2009).Sachet water is regulated as a food product in Nigeria by National Agency for Food and Drug Administration and Control (NAFDAC). The agency relies on World Health Organization (WHO) and Nigerian Standard for Drinking Water Quality (NSDWQ) standards for the product regulation, registration and certification. There has been a tremendous improvement in sachet water regulations by NAFDAC as the number of illegal producers has drastically reduced and most brands on sale now have NAFDAC registration. Sachet water is not completely sterile, since it may not be entirely free of all infectious microorganisms. The potential danger associated with sachet water is contamination, which is a factor of the source of the water itself, treatment, packaging materials, dispensing into packaging materials and sealing (Omalu *et al.,* 2010). Under prolonged storage of packaged water at favorable environmental conditions, total aerobic heterotrophic bacteria, indicators of faecal contamination and faecal coliforms can grow to levels that may be harmful to humans (Warburton *et al.,* 1992). Total aerobic heterotrophic bacterial counts are sensitive and practical indicators of water treatment efficiency as well as after-growth and biofilm formation. Some of the total aerobic heterotrophic bacteria have been identified as opportunistic pathogens (Prakash *et al.,* 2008). These microorganisms can be found in source waters and in treated drinking water (Mustapha, 2008). Thus, consumption of water containing large numbers of total aerobic heterotrophic bacteria can lead to diseases such as gastroenteritis and mucous membrane infections particularly in persons whose immune systems are compromised by AIDS, organ transplantation or chemotherapy (WHO, 2006). The physical and chemical contaminants can easily be prevented at the pre-production stages, but the microbial contaminants need a disciplined effort sustained by a high level of hygienic sanitation (Aroh, 2006; Olaniyan, 2016). Generally, the application of Good Manufacturing and Automated Process (GMAP) guidelines will reduce to the barest minimum the level of defects found in such products. Most impurities in packaging water originate from the raw water, but may persist in the purified water due to poor or inadequate purification techniques. Extrinsic contaminants however emanate from the environments in which the water is produced or the container (Omalu *et al,* 2010). The provision of an adequate supply of safe drinking water was one of the eight components of primary health care, identified by the International Conference on Primary Health care (Edema *et al.,* 2001). This study was set to investigate the storage effects on the quality of sachet water produced in Sabon Gari Local Government Area of Kaduna State, Nigeria.

MATERIALS AND METHODS

Study Area

The study area was Sabon Gari LGA of Kaduna state. Its headquarters are in the town of Sabon Gari, a major city in Kaduna state in Northern Nigeria. The 2006 Census population was estimated as 406,990. The Sabon –Gari economy is primarily based on agriculture. Zaria is also the center of a textile industry that for over 200 years has made elaborately hand-embroidered robes that are worn by men throughout Nigeria and West Africa. Sabon Gari Local Government Area is located in the Northern part of Kaduna State; it is about 11 to 12 kilometers away from Zaria main town which is made up of some areas, such as Samaru, Layin Zomo, Kwangila, Dogarawa, Hanwa and Palladan.

Sampling Site

This study was carried out in Sabon-Gari Local Government Area of Kaduna state which is situated on latitude 112^0 12" N and longitude 07^0 37" E, at an altitude of 550–700 meters. It is about 13 km from Zaria city on the Sokoto road, 8 km to Shika and 7 km from Basawa.

Sachet Water Sampling and Treatment

Reconnaissance survey was used to collect five sachet water brands (SWB) from five major sachet water retailers in Sabon Gari LGA. Two bags of each brand were collected and 3 sachets were removed from each bag and blended in a stainless electric blender to obtain homogeneity and then put in sterile polyethylene bag containers with leak proof lids. The (SWB) were delinked from their trade names and labeled as (SWB1-SWB5). This was immediately transferred within twenty four hours to Water Quality Laboratory of the National Water Resources Institute, Kaduna (NWRI) for subsequent physico-chemical and microbiological analyses.

Methodology

The tests carried out were physical, chemical and bacteriological parameters. The physical tests are; temperature, pH, colour, turbidity, total dissolved solids, electrical conductivity while the chemical and bacteriological parameters include; total alkalinity, chloride, total hardness, salinity, fluoride, iron, nitrate, total coliform and faecal coliform.

Test for Colour

Test for colour was done using the methods described by Dinrifo *et al*. (2010). A Lovibond visual colour comparator, M- 2000 was used. Five tubes of the Lovibond comparator was filled with each sachet water brand (SWB) and the sixth tube was filled with distilled water as standard control. Both tubes were placed in the comparator and adjusted by rotating the disc until a nearest colour match was observed. The results were then expressed in whole number and recorded as True colour units (TCU). This procedure was repeated every week for five weeks.

Determination of Temperature

Temperature was determined using the methods described by American Public Health Association (2005). 100ml of each sachet water brands (SWB) were measured into five labeled conical flasks. A pen type digital thermometer AST-17 was dipped into each conical flask containing the labeled (SWB).Steady temperature was measured and record in centigrade (^{O}C).This procedure was repeated every week for five weeks.

Determination of Turbidity

Turbidity was determined using the methods described by Dinrifo *et al*. (2010) using a turbid meter (HACH MODEL 2100A). The turbidimeter cell was rinsed thoroughly with distilled water, then with the five sachet water brand (SWB). Five cells in the turbid meter were filled with each (SWB) and their turbidity recorded and expressed in whole number as Nephelometric turbidity unit (NTU). The procedure was repeated weekly for five weeks.

Determination of Total Dissolved Solids (TDS) and Electrical Conductivity (EC)

The TDS and EC were determined using the methods described by American Public Health Association (2010). A TDS-EC-210 probe meter was used for these measurements. 100ml of each of the five sachet water brands were measured into 100ml beakers. The electrode of the conductivity meter probe was rinsed with each of the sachet water brands appropriately. A liquot of each brand was measured above the vent holes until it was fully immersed. The conductivity meter was switched on to conductivity mode and later TDS mode and their values recorded as ppm for TDS and ms/cm for EC.

Determination of pH

The pH was determined using the methods described by the Association of Analytical Chemists (AOAC, 1986). A digital electrode PH meter probe M-3520 was used for this measurement. 100ml of each sachet water brand was measured into five labeled beakers .The PH meter probe was rinsed with each of the (SWB) so as to avoid cross contamination. The pH meter probe electrode was fully immersed into each labeled 100ml beaker and the pH recorded accordingly.

Determination of Chemical Properties in Sachet Water.

The recommended method of the Association of Analytical Chemists (AOAC, 1990) was used for the determination of Alkalinity, Total Hardness, Chloride, Nitrite, Fluoride and Iron content in the five Sachet water brands weekly for four weeks and the results were expressed as (Mg/L).

Determination of Total and Faecal Coliforms

Total and faecal coliforms were determined using the methods described by AHPA (2005).
3.75g of Eosin Methylene Blue (EMB) Agar was weighed and dissolved in 100ml of distilled water.

Total coliform count.

Total coliform was determined by using Membrane Filtration Technique in accordance with ASTM D5392-93, APHA 9222B and WHO Guidelines for Drinking Water Quality (2001, Volume 3). Filtration unit comprising of Erlenmeyer flask, vacuum source and porous support were assembled through the membrane filter, the filtration unit was taken apart and with the aid of a sterile forceps. The membrane filter was placed in the Petri dish on the pad that had been saturated with Eosin Methylene Blue agar. The upper funnel was then removed and rinsed with 200ml of sterile Ringer's solution prior to use for the next sample. All plates were incubated in inverted position at 37±2°C for 24 h. After incubation, identified

and counted colonies that produced a greenish-gold colour with metallic sheen using a magnifying lens. The results were recorded and calculated using:

Coliform colonies/l00mL = Coliform colonies counted x 100
Volume of sample filtered (mL)

Faecal coliform count

Faecal coliform was determined by using Membrane Filtration Technique in accordance with ASTM D53 92-93, APHA 9222B and WHO Guidelines for Drinking Water Quality (2001, Volume 3). Filtration unit comprising of Erlenmeyer flask, vacuum source and porous support were assembled the through the membrane filter, the filtration unit was taken apart and with the aid of a sterile forceps. The membrane filter was placed in the Petri dish on the pad that had been saturated with Eosin Methylene Blue agar. The upper funnel was then removed and rinsed with 200ml of sterile Ringer's solution prior to use for the next sample. All plates were incubated in inverted position at 44±2°C for 24 h. After incubation, *E. coli* strains appeared as greenish with metallic sheen colonies and this was further confirmed by the ability of the organism to ferment lactose at 44.5 ^{0}C and colonies that produce a blue colour with metallic sheen. The results were recorded and calculated using:

Faecal Coliform colonies/l00mL = Coliform colonies counted x 100
Volume of sample filtered (mL)

RESULTS

The values on table 1 present the test results for the colour of five sachet water brands (SWB) stored for a period of five weeks. Though after five weeks all the five sachet water brands (SWB) demonstrated a slight change in colour they are still <15 True Colour Units (TCU) required for drinking water as shown in table1 below.

Table 1: Colour of Sachet Water Brands (SWB) in four Weeks Periods (Pt -Co).

SAMPLES	WEEK 1	WEEK 2	WEEK 3	WEEK 4
SWB 1	3	3	5	5
SWB 2	4	5	5	6
SWB 3	3	5	7	8
SWB 4	3	4	6	6
SWB 5	2	4	5	6

Results are mean of three replicates.

Table 2 below presents the temperature results for five sachet water brands after five weeks of production. All except sachet water brand SWB1 and SWB5 show a slight increase in temperature (29.0-29.5°C) and (25.0-25.1°C).SWB2, SWB3 and SWB4 all show a slight reduction in temperature after five weeks (27.3-27.1°C), (25.5-25.4°C) and (29.6-29.5°C) as shown on table2 below.

Table 2: Temperatures of Five Sachet Water Brands in Five Week Period (°C)

SAMPLES	WEEK 1	WEEK 2	WEEK 3	WEEK 4
SWB 1	29.0	28.8	29.2	29.5
SWB 2	27.3	27.3	26.9	27.1
SWB 3	25.5	25.3	25.3	25.4
SWB 4	29.6	29.2	29.4	29.5
SWB 5	25.0	24.8	25.0	25.1

Results are mean of three replicates.

The values in table 3 below present the electrical conductivity of five sachet water brands (SWB) after a four weeks period.Table3 shows that only SWB4 increased slightly in electrical conductivity after four weeks (204.0-210.5ms/cm). SWB1, SWB2, SWB3 and SWB5 show a slight reduction in their electrical conductivity (141.2-131.5ms/cm), (175.5-171.5ms/cm), (137.7-137.0ms/cm) and (165.0-161.1ms/cm) as shown in table 3.

Table 3: Electrical Conductivity of five Sachet Water Brand in four Week ((ms/cm)

SAMPLES	WEEK 1	WEEK 2	WEEK 3	WEEK 4
SWB 1	141.2	136.1	132.0	131.5
SWB 2	175.5	172.0	171.8	171.5
SWB 3	137.7	137.1	137.2	137.0
SWB 4	204.0	208.0	207.7	210.5
SWB 5	165.0	160.0	163.2	161.1

Results are mean of three replicates.

The chart display on figure 1 below showed an increase in pH in all the sachet water brands from week one to week four of storage. Although the pH of all the sachet water brands ranges from 7.45 in week one to 8.39 in week four averaging 7.49. SWB1 recorded the highest pH from week one to week four (8-8.39) when compared to other SWB. Even though there was fluctuations in pH for all the SWB, the pH still remains within the WHO acceptable limits for drinking water (6.5-8.50).

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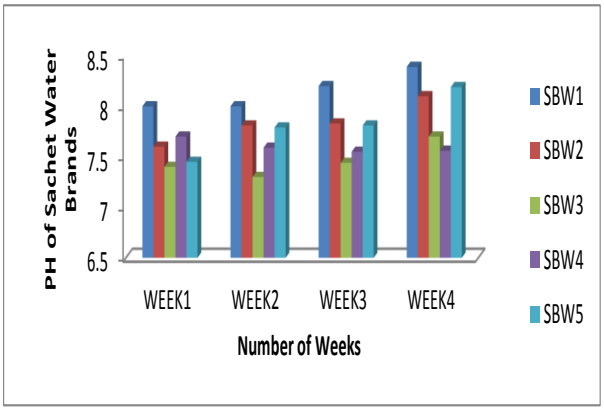

Figure1: pH of Sachet water brands (SWB) in four weeks.

The values displayed on figure 2 below is the total dissolved solids (TDS) for SWB1-SWB5. The results showed that all the SWB didn't show much variations in their TDS as all the values are >500ppm which is the acceptable limits for total dissolved solids in drinking water. This is so because SWB1-SWB5 has undergone treatment earlier.

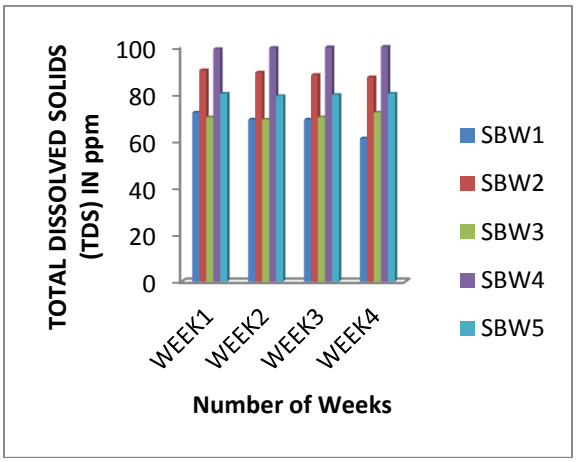

Figure 2: Total Dissolved Solids of Sachet Water brands in four weeks

Figure 3 below displayed the total alkalinity for five sachet water brands after four weeks of storage. The results figure 3 indicated a reduction in the total alkalinity for SWB1 (58-45mg/dl), SWB2 (79-70mg/dl), SWB3 (23-19mg/dl), SWB4 (45-39mg/dl) and SWB5 (63-59mg/dl) after four weeks of storage, with SWB2 and SWB3 recording the highest and lowest total alkalinity (79mg/dl and 19mg/dl) respectively.

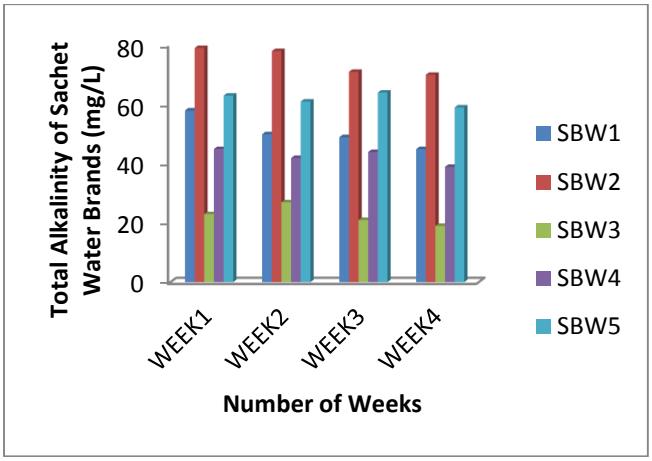

Figure 3: Total Alkalinity in five sachet water brands in four weeks of storage

The values in figure 4 below present the total hardness of SWB1-SWB5 in four weeks. The values demonstrated that all the sachet water brands had total hardness of 40-81mg/l in four weeks which is less than 100mg/l, the WHO/NAFDAC acceptable limit. Figure 4 showed SWB2 had the highest total hardness (81mg/l) and SWB3 had the lowest (50mg/l), respectively.

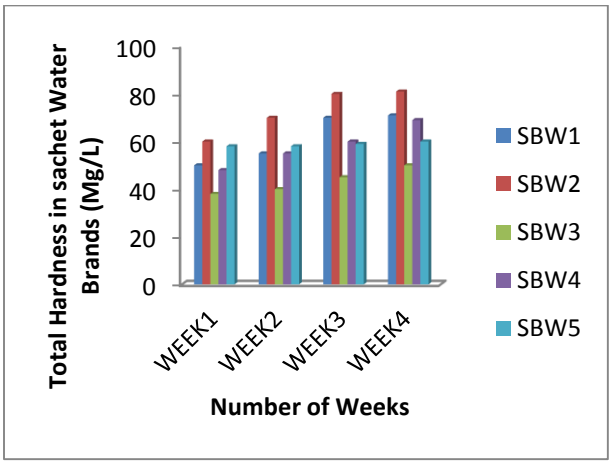

Figure4: Total Hardness in sachet water brands in four weeks

The results in figure 5 are the chloride concentrations for SWB1-SWB5 in four weeks after production. Figure 5 showed SWB1 with the highest concentration of chloride (160mg/l), while SWB3 has the lowest (20mg/l) after four weeks of storage.

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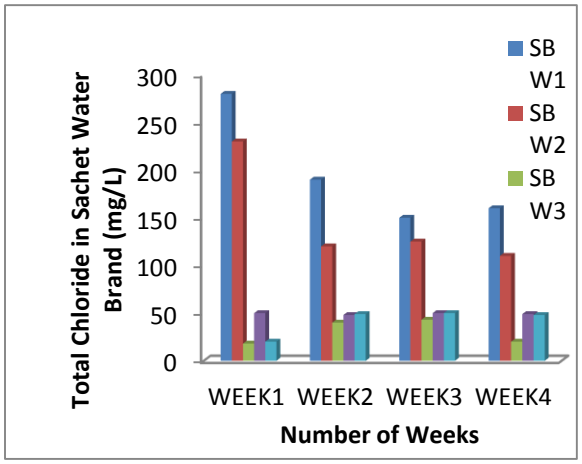

Figure 5: Chloride concentration in sachet water brands in four weeks

Concentration of nitrate is presented below in figure 6. The results demonstrate a reduction in the Nitrate concentrations ranging from 0.3-1.35mg/l in week one to 0.18-1.2mg/l on the fourth week of storage. Figure 6 showed SWB4 had the highest Nitrate concentration (1.20mg/l) and SWB2 had the lowest (0.18mg/l) in the fourth week respectively. All the sachet water brands were less than the permissible limit of 10mg/l of Nitrate required for treated drinking water.

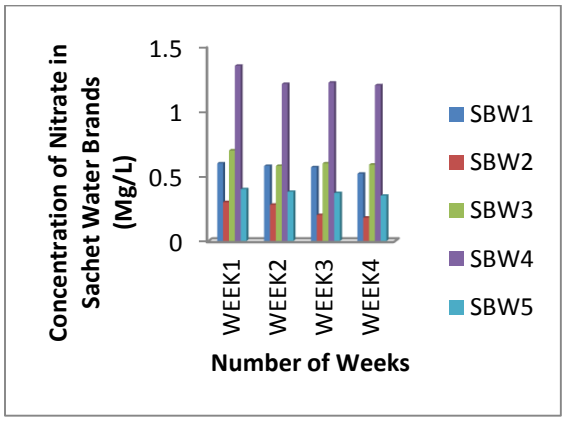

Figure 6: Chloride concentration in sachet water brands in four weeks.

The concentration of Fluoride is presented below in figure 7. The results indicated a fluoride concentration ranged from 0.18-0.99mg/l of fluoride in week 1 to 0.23-1.20mg/l in the fourth week of storage. SWB4 had the highest concentration in week one (0.99mg/l) and week four (1.2mg/l) while SWB3 had the lowest concentration of fluoride in week one and week four (0.18 mg/l and 0.23mg/l) respectively.

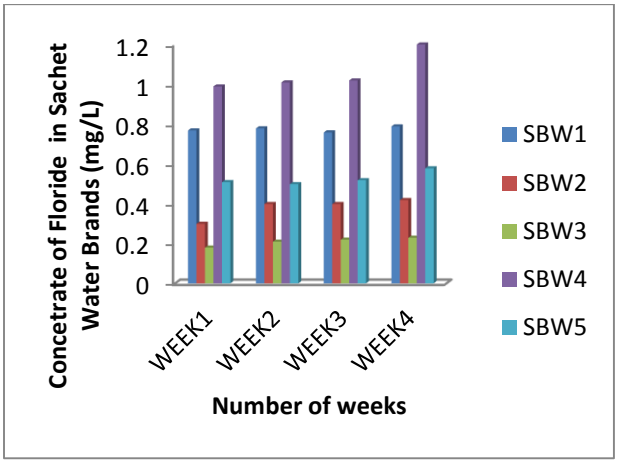

Figure 7: Fluoride concentration in sachet water brands in four weeks

Iron concentration (figure 8) is shown below. SWB1-SWB5 showed iron concentration to range from (0.00-0.05mg/l) between one to four weeks of storage. This value indicated all the sachet water brands had iron concentration less than 0.3mg/l the WHO/NAFDAC permissible level of iron in treated drinking water.

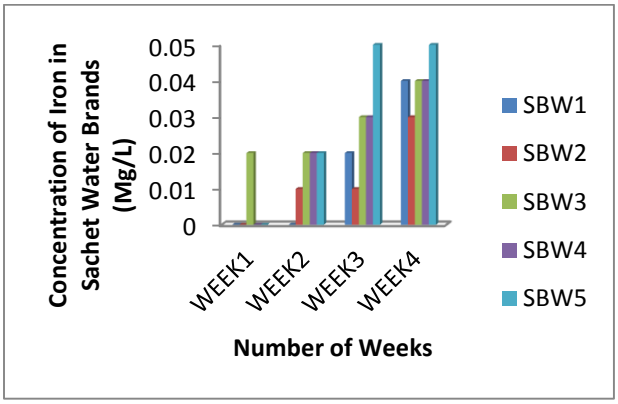

Figure 8: Iron concentration in sachet water brands in four weeks.

The results on table 4 below showed that SWB5 had the highest number of coliform colonies count (25colonies) after four weeks of storage. This was followed by SWB2, SWB4, SWB3 and SWB1 with 20, 17, 11 and 4 colonies forming unit. Although SWB1 has the lowest number of 4 colonies forming unit/100ml, all the sachet water brands have bacterial contamination after four weeks of storage. High coliform populations in water are an indication of poor sanitary conditions in the sample. Inadequate and unhygienic handling of solid-wastes in the environment could have generated high concentration of microbial organisms

Table 4: Total coliform forming count (MPN/l00ml) of Sachet Water in 4 Week Period

SAMPLES	WEEK 1	WEEK 2	WEEK 3	WEEK 4
SWB 1	1	5	7	4
SWB 2	25	29	32	20
SWB 3	13	17	26	11
SWB 4	9	15	19	17
SWB 5	19	22	27	25

Results are mean of three replicates.

The results in table 5 below are a biochemical test to confirm the presence of E. *coli* in five sachet water brands (SWB) at the fourth week. The negative results showed on table 5 for Methyl Red and Indole test and positive citrate utilization test confirms the absence of E. *coli* and equally confirmed the presence of *Enterobacter spp* due to the positive biochemical results for citrate in all the SWB on the fourth week.

Table 5: Biochemical and Confirmatory Test of Sachet Water Brands in the fourth week

Sachet Water Brands	Citrate Utilization Test	MR/VP Test	Indole Test	Inference
SWB1	+	_	_	*Enterobacter spp*
SWB2	+	_	_	*Enterobacter spp*
SWB3	+	_	_	*Enterobacter spp*
SWB4	+	_	_	*Enterobacter spp*
SWB5	+	_	_	*Enterobacter spp*

DISCUSSION

This study investigated physical, chemical and microbiological properties of some sachet water brands produced from the study areas even though their consumption are not limited to this area only. All the companies were NAFDAC registered. The assessment of physiochemical and microbiological attribute determines the aesthetic value (pleasantness, palatability and acceptability of sachet water), poor storage conditions can affect the quality of packaged sachet water weeks after production (Denloye, 2004).The results on tables 1-3, figures 1 and 2 showed the physical properties of SWB1-SWB5 after four weeks of storage. The results indicated variations in colour, temperature, pH, electrical conductivity and total dissolved solids. All the sachet water brands had Colour <5TCU, Temperature <30^{o}C, pH (6.5-8.5), Electrical conductivity <1000ms/cm and total dissolved solids <500 Mg/l. Results in tables 1-3, figures 1 and 2 clearly revealed that even though there are variations, the physical properties of SWB1-SWB5 after four weeks of storage are within the WHO permissible limit for treated drinking water, this is an indication of effective physical treatment and adherence to good manufacturing practice (GMP) by all the five water factories sampled in this study. This result is also consistent with the findings of other investigators who worked on the physical and chemical characteristics of sachet water supplies in other parts of the country (Ajayi *et al*., 2008). The presence of chemical compounds above the permissible limit for treated drinking water had been shown to affect the quality and shelf life of water (APHA, 2005).The values presented in figures 3-8 of this study showed the total alkalinity, total hardness, Chloride, Nitrate, Fluoride and Iron concentrations in five sachet water brands after four weeks of storage. The Alkalinity is the ability of water to absorb hydrogen ions (Mustapha *et al*., 2013). The values in figure 3 ranged from 18-77 mg/1 averaging 47.5mg/l, the total alkalinity of all the sachet water brands were below the NAFDAC/WHO acceptable limit for drinking (80 to 120 mg/l), our findings also agree with the that of (Edema *et al.,* 2011) who reported low alkalinity level in some sachet water brands consumed in some part of Nigeria. The total hardness levels (Fig. 4) were lower than the WHO permissible limits of 100mg/L. Drinking water with hardness less than 75mg/L may have adverse effects on mineral balance in the body (WHO, 1989). In this study the total hardness of all the sachet water brands ranged from 38-80mg/l. SWB2 and SWB3 recorded the highest and lowest amount of total hardness (80 and 39mg/l). This results agree with the findings of Alhassan *et al,* (2008) who observed same. Chloride value ranged (figure 5) from 18-280mg/l after four weeks of storage respectively. The highest chloride concentration was recorded by SWB1, SWB2, SWB4 and SWB5 with 160mg/l, 110mg/l, 49mg/l and 48mg/l while SWB3 record the lowest chloride level 20mg/l after four weeks of storage. According to WHO (2011), standard concentration of chloride should not exceed 250 mg/l. Chloride concentration were found to be below the permissible limit when compared with that of Nigeria Standard for Drinking Water Quality on the fourth week, although there was a reduction in the chloride level from SWB1-SWB5. Chlorides is mainly obtained from the dissolution of salts of hydrochloric acid as table salts; NaCl and $NaCO_2$ which are added through industrial waste, sewage and sea water. It has key importance for metabolism activity in the human body and other main physiological processes. High chloride concentration damage metallic pipes and other structures as well as causing harm to growing plants (Muhammed *et al.*, 2013).Nitrate values (figure 6) obtained for all the sachet water brands in this study ranged from 0.3-1.35mg/l after four weeks of storage respectively. The NSDWQ maximum permissible limit of nitrate in drinking water is 10 mg/l. The results indicate that the concentration of nitrate in all the sachet water brands in this study is less than the acceptable limits. Nitrate is one of the most important disease causing parameters of water, particularly the blue baby syndrome in infants. Nitrate get into water through chemical fertilizers, soil, foods, glass and explosives (WHO, 2007). These compounds are very soluble in water and can enter surface water when it rains, or groundwater through leaching. Nitrate is a normal component of the human diet and it is relatively non-toxic, but when swallowed, it

is converted to nitrite which reacts with the haemoglobin in the blood causing methaemaglobin, which under high concentration could result in coma and death, especially in infants. Fluoride inhibits enzymes that breed acid-producing bacteria whose acid eats away tooth enamel. Excessive fluoride intake leads to loss of calcium from the tooth matrix, aggravating cavity formation throughout life rather than remedying it and so causing dental fluorosis. The values in figure 7 show the level of fluoride in SWB1-SWB5 after four weeks of storage. The values on figure ranged from 0.18-1.20mg/l with SWB4 having the highest fluoride level (1.20mg/l) at the fourth week while SWB3 recorded the lowest (0.23mg/l) at the fourth week. Results from this study indicated that the fluoride level in SWB1-SWB5 is less than the WHO limit for treated drinking water (5mg/l), this could likely be due to the earlier treatment and this finding is in agreement with the study of Akpata *et al.,* (2007) who reported low level of fluoride in Northern Nigeria. The concentrations of iron (figure 8) above showed all the sachet water brands (SWB1-SWB5) were below the WHO, NSDWQ and NAFDAC standards of 0.3 mg/l. The recommended limit of 0.3 mg/l for iron in water is based on taste and appearance rather than on any detrimental health effect. When its level in water exceeds the 0.3 mg/l limit, the water may have a metallic taste and an offensive Odour. Water system piping and fixtures can also become clogged (Ndamitso *et al*., 2013).The values on figure 8 clearly showed that SWB1 and SWB5 recorded the highest concentration of iron on the fourth week (0.05 and 0.04mg/l). Concentration of iron in SWB3 (0.03mg/l) is the lowest after four weeks. The results from this study is in agreement with a study on the storage and quality of sachet water produced within Port Harcourt metropolis, Sunday *et al.,* (2011) who reported low-level of iron and recommended that the expiry date for sachet water should not exceed four weeks from the date of its production, because prolong storage was found to deteriorate its physico-chemical qualities. The results in table 4 showed that all the sachet water brands had coliform colonies (4-25 colonies) after four weeks of storage. SWB5, SWB4 and SWB3, (25, 20 and 17 CFU/100ML) had the highest colonies forming units after four weeks of storage. The biochemical results table 5 confirmed the presence of faecal coliform bacteria known as *Enterobacter,* though the samples did not contain *E-coli and Salmonella typhi*. High coliform populations are an indication of poor sanitary conditions in the sample. Inadequate and unhygienic handling of solid-wastes in the environment could have generated high concentration of microbial organisms. This is similar to Adeyeye *et al,* (2017) and Nwokem *et al,* (2017) who reported that larger proportions of sachet water investigated show positive coliform counts, E. coli and Enterobacter spp. This study advocates for proper water treatment by water manufacturers and strict monitoring for compliance by concerned regulatory agencies.

CONCLUSION

The findings from this study revealed all the physiochemical parameters of the sachet water brands sampled are within WHO and NSDWQ acceptable limits for drinking water after four weeks. The Study showed bacterial contaminations (***Enterobacter spp***) in all sachet water brands sampled in Sabon Gari Local Government Area after four weeks of storage. To reduce the high incidence of sachet water contamination good and proper personal and environmental sanitary practices must be maintained in and around the factory and NAFDAC should ensure the presence of in-house laboratories in all factories as this will also go a long way in averting the danger of waterborne diseases.

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