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PHYSICOCHEMIAL AND BACTERIOLOGICAL ANALYSIS OF SACHET WATER IN SULEJA LOCAL GOVERNMENT AREA OF NIGER STATE, NIGERIA

Chukwu. M. N.[1] and Olise, E. O.[2]
[1,2]Biology Unit, Department of Pure and Applied Sciences faculty of Science,
National Open University of Nigeria Headquarters,
Plot 91, Cadastral Zone, NnamdiAzikiwe Expressway, Jabi - Abuja
*E-mail: mchukwu@noun.edu.ng

ABSTRACT:
Sachet water was introduced in Nigeria to provide safe, hygienic and affordable instant drinking water to the general public. The aim of the study was to examine the Physicochemical and bacteriological analysis of sachets water produced in Suleja LGA of Niger state. Two brands of sachet water (X and Y) were collected within 24hours of production (in bags), transported to the laboratory (WUPA WASTE WATER TREATENT PLANT) and analyzed. The Samples were stored at ambient room temperature. The Samples were analyzed on weekly basis for a period of eight (8) weeks using standard procedures to assess the quality of sachet water consumed in the area. The results showed variations in the concentrations of the analyzed parameters in the water samples. The physicochemical parameters were within World Health Organization and SON limits. The pH values ranged from 6.50 – 6.65; Conductivity ranged from 68.9 – 72.8µS/cm; Alkalinity ranged from 21.0 – 26.0mg/l; Total Dissolved Solids ranged from 35.8–38.2mg/l. The bacteriological parameters e.g Escherichia coli (E. coli) and shegella were not detected in all the samples during the period of study. The water samples were colourless and odourless. In general, the concentrations of the physical, chemical and bacteriological parameters analyzed in the samples were within the World Health Organization (WHO) permissible limits, indicating that the sachets water sold in Suleja were safe for human consumption.

Keywords: Physicochemical, pH, Alkalinity, Temperature, Bacteriological count

1.0 INTRODUCTION

Life on Earth depends upon water. Water comprises 99% of our bodies and covers 71% of the earth's surface (Willy *et al*., 2008). It serves different functions ranging from transport through serving as solvent for most chemicals to being a habitat to many organisms. Water is needed by all forms of life; man, animals and plants, and exists in three states; vapor, liquid and solid. Water supplies are derived from springs, rivers, reservoirs, boreholes and natural lakes. Water passes through the ground, during which it dissolves some minerals in rocks, suspended particles, and pathogenic microorganisms from feacal matters. These and other factors make some water unfit for drinking. There is almost a global shortage of water and the world's most urgent and front rank problem today is supply and maintenance of clean drinking water. In modern times, many developing countries have included in their national plans the supply and utilization of safe drinking water. Fresh drinking water is one of the natural resource which is necessary for existence and survival of humans (Abdullahi *et al.,* 2010).

Potable drinking water serve as an important pillar for prevention of diseases and it continues to be the foundation for the prevention and control of water borne diseases (WHO, 2010; Isa *et al.,* 2013; Okonko*et al.,* 200). The importance of potable water supply in the socio-economic life of communities cannot be overemphasized. Often, source and portability of water supply reflects on the health conditions of communities as microbiological contamination of water is the primary cause of disease outbreaks in many communities particularly in developing countries. The transmission of disease through drinking water is, therefore, one of the primary concerns for safe water supply (Ahmed *et al.,*

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2004; Popoola *et al.,* 2007). The danger that unsafe drinking water poses to health is enormous (Njoku and Osinlu, 2007; Oparaocha*et al.,* 2010). Ensuring good drinking water quality is a basic factor in guaranteeing public health, the protection of the environment and sustainable development.

As an alternative, private sector participation has led to the idea of packaged drinking water popularly referred to as "pure water".

This product is widely patronized by both low and middle income earners (Addo *et al*., 2009). Sachet- water or pure water is classified as food and is regulated and screened by National Agency for Food and Drug Administration and control in Nigeria, whose bacteriological standards are as recommended by World Health Organization (Afiukwa*et al.,* 2010). Many people in rural and urban communities rely on sachet water as the source(s) of their drinking water supply.

Osibanjo*et al*., (2000) inferred that 50% of the "pure water" sold in the streets of Lagos may not be fit for human consumption. The possibility is that the same situation may be applicable to other cities in the country.Water borne diseases such as cholera, Guinea worm disease, Typhoid and Dysentery are caused by drinking contaminated water.

There is therefore need to analyze the physical, chemical and bacteriological parameters as well as some anions and heavy metals' levels in sachets water consumedin Suleja Local Government Area of Niger State in order to ascertain whether they conform to the recommended standards for potable water.

2.0 MATERIALS AND METHODS

2.1 Study Area

Suleja is a city in Niger State, Nigeria, north of Abuja. It is also recognized as a centre of excellence for traditional West African pottery. Suleja Local Government Area is situated in the city of Suleja and the area council consists districts of Apia, Bagama, Buru, Burum, Bwoi, Chimbi, Chizako, Dachine, Dwakoro, Gauraka, Gupena, Gusun, Hashimi, Ibo, Iku South, KuurminSarki, Ikume and other. It is cited between latitude 9° 10' 60.00" North of the equator and longitude 7° 10' 60.00" 3'20" East of the Green which meridian (Figure 1).

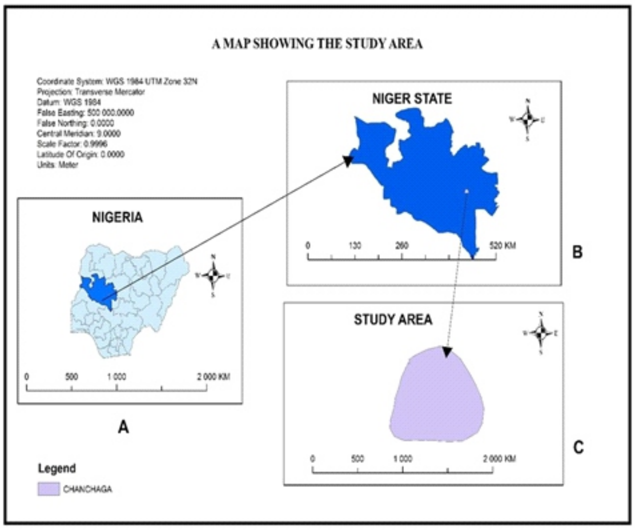

Figure 1: *Map of collection point in Suleja Local Government Area of Niger state, Nigeria*

2.2 Collection of Samples

Two (2) brands of sachet water (X and Y) were randomly collected from different sachet water factories (Progress table water factory and FC Blessed factory) in different parts of Suleja, Niger state within 24 hours of production. All samples were taken to Abuja Sewage Plant Laboratory and stored in a room at ambient temperature for laboratory analysis. The analysis was carried out for eight (8) weeks, to enable one know the changes in chemical composition that occurred per week.

2.3 Determination of Physicochemical Parameters

The appearance of the water samples was observed virtually and the water was inhaled to detect any colour andodour. The physicochemical parameters; temperature, conductivity, Hydrogen ion concentration (pH), Turbidity, Total hardness, Dissolved Oxygen (DO), Total Dissolved Solids (TDS) and Total Suspended Solid (TSS) were determined using Electrometric method (APHA, 2005).

2.4 Alkalinity; was obtained using titrimetric method.

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2.5Bacteriological Analysis

2.5.1 Determination of Total Coliform Count and Fecal Coliform Count

Total coliform count and fecal coliform counts were determined as described byWilley *et al*., (2008).

2.5.2 Heterotrophic Plate Count

Tenfold serial dilution of water samples were prepared in sterile distilled water. The 102 and 106 dilutions were used. From this 0.1ml of the sample was aseptically transferred onto the center of a prepared plate agar (Oxide) a sterile glass rod was used to spread the water sample on the surface of the media. The plate was incubated at 37°C for 24hours.

2.6 Analysis of Data

Data were analyzed using two way analysis of variance at 5% level of significance ($P < 0.05$).

3.0 RESULTS AND DISCUSSIONS

Table 1: Progress and FC blessed table water (**X** and **Y** brand) limits for various parameters expressed as mean

PARAMETERS	PROGRESS WATER	FC BLESSED TABLE WATER	NIGERIAN STANDARDS OR DRINKING WATER (SON & EDERAL MINISTRY OF HEALTH (MH))
pH	6.57	6.60	6.5 – 8.5
Temperature (°C)	263	26.13	24.5
Conductivity (μ/cm)	71.6	71.61	1250.0
Total Dissolved Solids (TDS) (mg/l)	37.25	36.24	500.0
Turbidity (NTU)	1.45	1.23	5.0
Total Suspended Solids (TSS) (mg/l)	1.64	1.49	<10
Total Hardness (mg/l)	19.86	17.49	150.0
Total Alkalinity (mg/l)	23.7	23.15	100.0
Ammonia (mg/l)	0.18	0.18	0.5
Nitrate (mg/l)	5.06	4.43	50.0
Nitrite (mg/l)	0.08	0.06	0.1
Chloride (mg/l)	19.5	19.55	250.0
Phosphate (mg/l)	0.05	0.07	5.0
Free Chlorine (mg/l)	0.12	0.15	0.2
Total Coliform (cfu/ml)	2.00	1.88	10.0
E. coli (cfu/ml)	0.00	0.00	NIL
Shegella(cfu/ml)	0.00	0.00	NIL

Table 1 present the results of the physical, chemical and bacteriological characteristics of the sachet water samples as meansfor eight weeks. All the samples were colourless and odourless, while they have taste between weeks 4 and 8.

Temperature values of the sachet water samples as presented in Figure 2 showed that values ranged from 23.5 - 27.0°C from the first to third weeks and 24.0 - 27.0°C from week four to week eight. The temperature values of the two sachet water were relatively steady throughout the investigation period and were also within the acceptable optimal growth range for mesophilic bacteria including human pathogens.

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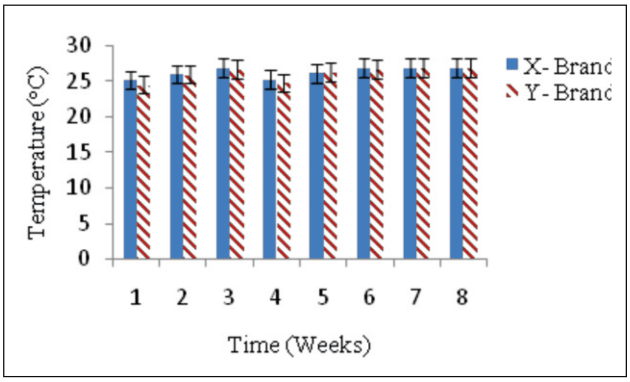

***Figure 2**: Variations in Temperature (°C) of the two sachet water samples. Values shown are Mean ± SE*

There is no significant difference (P<0.05) in the temperature values of the two sachet water samples throughout the study period.

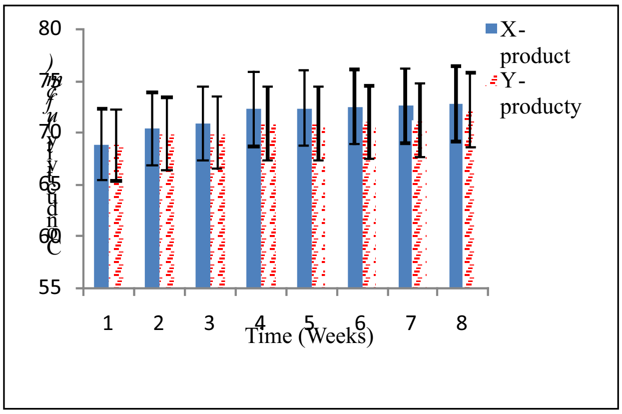

Figure 3: Variations in Conductivity *(uf/cm)* of the two sachet water samples. Values shown are Mean ± SE

The conductivity values of the samples ranged from 68.8 -70.90(µs/cm) for the first three weeks and 70.90 -72.50(µs/cm) from week 4 to week 8 (Figure 3). Sample Y recorded slightly lower conductivity throughout the study period. All these values were within the acceptable standards of SON and FMH. There is however no significant difference (P<0.05) in the conductivity values of the two sachet water samples throughout the study period.

The Turbidity of the samples ranged from 0.6 – 1.2 NTU in the first three weeks of production and 0.9 – 2.2NTU from week 4 to week 8. The average values showed that there was an increase in the turbidity of the samples after three weeks (Figure 4). However all the values were within the limits of SON and FMH.There are significant differences (P<0.05) in the turbidity values in between the sachet water samples from week four to the eight.

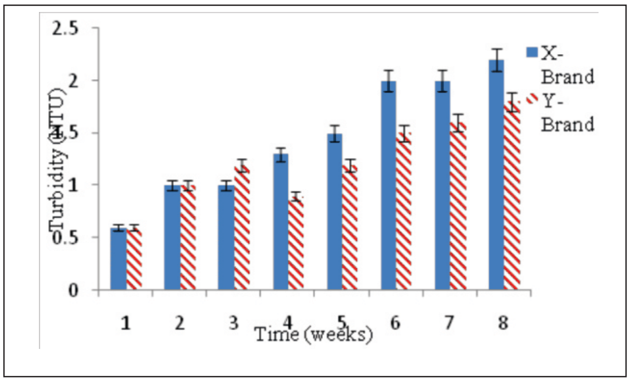

***Figure 4**: Variations in Turbidity (NTU) of the two brands of sachet water. Values shown are Mean ± SE*

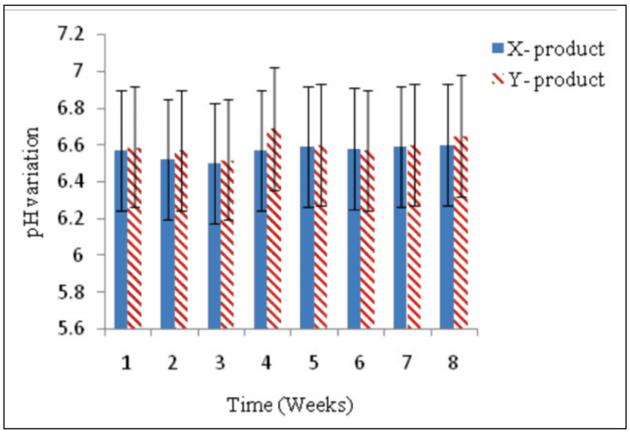

***Figure 5:** Variations in pH of the two Sachet Water samples. Values shown are Mean ± SE*

The pH values of the two sachet water samples were relatively steady with no significant difference between them throughout the study period (Figure 5). The variations of pHvalues however were within the permissible limits of SON and FMH.

The Total Hardness of the two samples ranged from 12.0 – 14.5 (mg/l) in the first three weeks and 18.0 – 25.0 (mg/l) from week 4 to 8 (Figure 6). Sample Y recorded higher total hardness in the first three weeks after which sample X recorded higher total hardness for the rest of the study period. However, all the values were within the acceptable limit of SON and FMH.

The presence of high concentration of calcium and magnesium salts in water is an indication of hardness which can be attributable to the geological formation of the source of the water samples. This agrees with the findings of Isikwue and Chikezie, (2014)

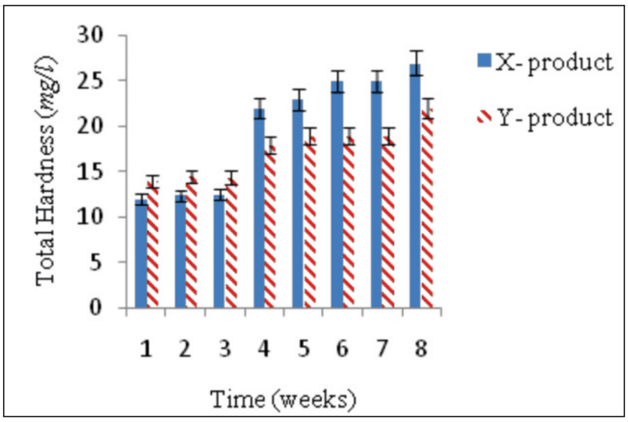

Figure 6:*Variations in Total Hardness (mg/l) of the two sachet water samples. Values shown are Mean ± SE*

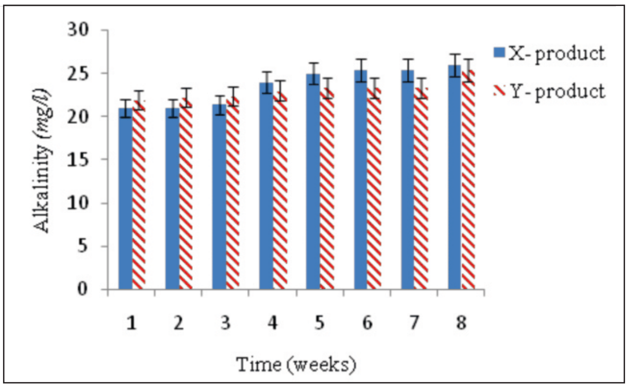

Figure 7: *Variations in Total Alkalinity (mg/l) of the two sachet water samples. Values shown are Mean ± SE*

There is a gradual increase in the total alkalinity values of the two sachet water sample throughout the study period (Figure 7). Sample Y recorded higher total alkalinity values in the first three weeks after which sample X recorded higher total alkalinity valuesfor the rest of the study period. All values were within the acceptable limit of SON and FMH. There was however no significant difference (P<0.05) in total alkalinity values of all the samples.

The average values of the Total Dissolved Solid(TDS)mg/l in the sachet water samples within first three weeks of production were 35.8-37.1mg/L and after three weeks of storage the average values increased to 35.9-37.3mg/L (Figure 8). However, and all the values were within the SON and FMH permissible limits (Table 1). There was no significant difference (P<0.05) in TDS of all samples.

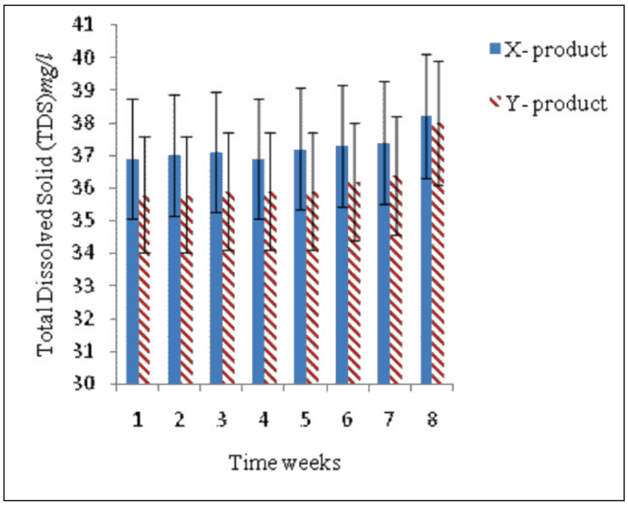

Figure 8: *Variations in Total Dissolved Solid (TDS) mg/l of the two sachet water samples. Values shown are Mean ± SE*

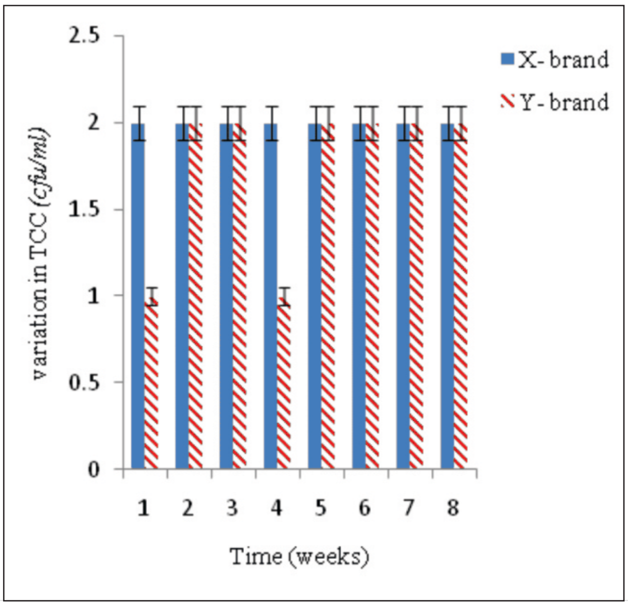

Figure 9*: variations in TCC (cfu/ml) of the two brands of sachet water samples. Values shown are Mean ± SE*

Result of analysis of the two brand samples of sachet water within week 1 to week 8 accounted for Coliform Count of 1.00-2.00 (cfu/ml) (Figure

9). Brand X maintained a constant value of2.00 cfu/ml all through the study period. Brand Y water sample on the other hand showed a slight increase in Coliform Count between week1 and 2, a slight decrease at week 4 and a further increase at week 5 leveling off at 2.00 cfu/ml (Figure 9). There was however no significant difference ($P<0.05$) in the TCC of the sachet water samples after the storage period (Figure 8). Total coliforms are widely used as indicators of the general sanitary quality of treated drinking water, while faecal coliforms give a much closer indication of faecal pollution (Ashbolt*et.al*, 2001) and consequently, SON's limit is that none should be detected by any means.

4.0 CONCLUSION

It was evident from the study that sachet water sampled in Suleja at the first week of production met the recommended standards for all physical and chemical qualities, however analytical results revealed that prolonged storage caused an increase in pH. The study also confirmed that presence of dissolved oxygen coupled with availability of organic material and nutrientswhich aided continuous and rapid proliferation of bacteria in the sample of sachet water tested over time. Based on the results, it could be concluded that the physicochemical and bacteriological parameters of sachets water consumed in Suleja LGA of Niger State conformed to the SON and FMH recommended standards for potable water and that the consumption of the sachets water may not pose health hazards to the consumers at the time of the study. Since the analyzed parameters may cause great health problems to humans at concentrations greater than the recommended standards.

4.1 Recommendations

From the findings of the study, it is recommended that:

1. Ideal preservation method should be exposed to the people concerned with sachet water production, distribution and consumption in the zone and the nation at large.
2. For the safety of sachet water consumers, the storage duration should not exceed twenty-one (21) days.
3. Periodic sanitary inspection of sachet water factories by the regulatory body is absolutely necessary to ensure conformity.
4. The levels of the studied parameters in sachet water samples obtained in the study area and it's environ be constantly monitored in order to ascertain the suitability of such water for human consumption.

5. Mandatory production date should be sealed on the body of sachet water for the end user to see so as to inform their purchase and consumption

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