FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 6 No. 2, April, 2022, pp 81 - 87
DOI: https://doi.org/10.33003/fjs-2022-0602-926

QUALITY ASSESSMENT FOR SOME SACHET WATER PRODUCED IN ENUGU METROPOLIS, ENUGU–NIGERIA

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ABSTRACT

This study investigated the quality of some sachet water brands produced in Enugu metropolis for drinking purpose. Five different brands of sachet water were collected from their production plant and their physical, chemical and bacteriological qualities were examined. The results obtained for physical parameters showed that turbidity was 0 NTU; total dissolved solid was between 86.19 – 140.12 mg/L; total suspended solid, 0 mg/L; total solid 86.19 - 140.12 mg/L; electrical conductivity, 60.80 – 150.30 µs/cm^3; total hardness, 0 mg/L; pH, 6.90 – 7.00 and alkalinity 50 mg/L. The result of the physical and chemical parameters conformed to the standards established by World Health Organization (WHO) and Nigeria standard for drinking water quality (NSDWQ). Similarly, biological contamination was absence in all the tested water samples. Thus, the examined sachet water brands were considered safe for consumption.

Keywords: Assessment, Enugu, Metropolis, Quality, Sachet**,** Water

INTRODUCTION

It has been noted that adequate supply of fresh and clean drinking water is a basic need for all human beings (Edema *et al.*, 2011) and water is one of the indispensible resources for continued existence of all living things including man. The UN general assembly at its 58th session declared the year 2005-2016 as an international decade for Action "water for life". This is to help reduce by half the population of people without access to sustainable improved drinking water. However, making potable water obtainable to the population is necessary to prevent health threats (Rahmanian *et al*., 2015). World Health Organization (2011) revealed that 75% of all the diseases in developing countries are associated with polluted drinking water. Drinking water contamination by different microorganisms such as coli forms (Kumpel *et al.*, 2016), Staphylococcus aureus and Pseudomonas species (Igbeneghu and Lamikanra, 2014) have been reported in Nigeria.

Drinking water that is fit for human consumption is expected to meet the world health organization and be free from physical and chemical substances and microorganisms in amount that is not hazardous to health. However, metals like iron, calcium, chromium and aluminum have been found in surface water (Titilawo *et al.*, 2018) and sachet-packed water (Emenike *et al.*, 2018). Similarly, cadmium, lead, manganese and nickel have been found in groundwater (Ayedun *et al.*, 2015) above permissible levels for drinking. Other contaminants such as fluoride (Emenike *et al*., 2018) and light polycyclic aromatic hydrocarbons have also been reported to be present in groundwater in levels above permissible limits in some locations in Nigeria (Adekunle *et al*., 2017).

Sachet water production in Nigeria started in the 90s and today the advancement in scientific technology has made sachet water production one of the fastest growing industries in the country. There has been an increasing trend in the production, marketing and consumption of locally produced sachet water (Muhammad and Dansabo, 2018) popularly known as pure water in Nigeria both in the urban and rural areas of Nigeria and so many parts of the continent. Continuous increase in the sale and indiscriminate consumption of packaged drinking waters in Nigeria is of public health significance (Oyedeji *et al.*, 2010). In Nigeria particularly, there is an astronomical increase in the consumption of packaged waters especially bottled and sachet drinking water (Oyedeji *et al.*, 2010). The increased demand for these drinking water products is attributed largely to factors such as inadequate or non-availability of reliable, safe municipal water in urban and rural areas. One major sources of potable water in Enugu city is boreholes. Majority of which are located at Ninth mile, a locality near Enugu metropolis where most natural sources of water are found (United Nations Millennium Development Goal, 2011). Enugu is a fast growing and population expanding city in Nigeria whose demands for potable water is becoming critical for water purification industries to meet up with supply. This is one of the reasons why consumption of sachet water in Enugu is on the increase irrespective of whether they have NAFDAC certification or not.

Studies on quality of drinking water in different parts of Nigeria revealed high contamination in the various samples of drinking water (Alli *et al.*, 2011). Study by Oyedeji *et al.* (2010), "Microbiological quality of packaged drinking water brands marketed in Ibadan metropolis and Ile-Ife city in South Western Nigeria" disclosed some level of contaminations in some packaged water in the areas under studied. Similarly, a study in a tertiary institution in South-West Nigeria on "Potability assessment of sachet water sold within Federal University of Agriculture, Abeokuta campus" by Opafola *et al*, (2020), revealed that taste and odor of all the water samples were innocuous. The total bacteria count (TBC) observed in all the brands ranged from 200 to 1700 cfu/mL, they noted also that of all the samples tested, that sample F had the highest TBC of 1700 cfu/mL while sample A had the lowest TBC of 200 cfu/mL. All the tested water samples failed to comply with WHO recommended standard of 100 cfu/mL for total heterotrophic count in drinking water. While several studies in some parts of Nigeria have documented the failure of the sachet water to meet minimum WHO quality standards, no similar study has been carried out in Enugu metropolis, Enugu State, Nigeria. Therefore, the purpose of this study is to investigate the level of physical, chemical and biological contaminations in five selected sachet water manufactured, sold and most consumed in Enugu metropolis and nearby

environs as some sachet water in our markets could serve as possible routes of transmission of protozoan parasites (Alli *et al*., 2011). Ajai *et al*. (2014) noted also that presence of impurities and foreign matter in finished products for human consumption is of great concern because they present health hazards when they exceed beneficial limits.

Study Area

Enugu urban lies approximately between latitude 6º 21' N and 6º 30'N and between longitude 7º 26' E and 7º 37'E. The total area coverage is approximately 72.8 square kilometers. Enugu urban comprises of three council areas Enugu North, Enugu East and Enugu South Local Government Areas. It is bounded in the West by Udi Local Government Area, in the North by Igbo-Etiti and Isiuzo Local Government Area and in the south by Nkanu West Local Government Area. It has a population of about 244,852, people which comprises of traders, civil servant peasant farmers and students. The predominant soil type is gravely-silt which is reddish in colour and has high density bearing capacity for intense building construction (www.unn.edu.ng/publications/files). Figure 1 shows the map of Enugu State.

Figure 1: Map of Enugu State *(Source: The National Mirror. 2012)*

MATERIALS AND METHODS

Materials used for the Study

- Aqua Rapha Sachet water (Sample A) produced by Aqua Rapha Investment Nigeria limited situated opposite Nigeria Brewery Plc. Ngwo, Enugu State with NAFDAC Reg. No. 01-0298L
- Parks Sachet water (Sample B) produced by Parks Ventures at No. 5A Idaw River Avenue, One Day Road, off Agbani Road, Enugu State with NAFDAC Reg No. 01-0298L.
- Baura Sachet water (Sample C) produced by Vaipre Nigeria Ltd at plot no. 866 Premier Layout, Ogui Nike , Enugu North L.G.A., Enugu State with NAFDAC REG No C1-7375L.
- Andex Sachet water (Sample D) produced by Beejay and Kate Nanny Hollywood Company Nigeria,NAFDAC Reg. NO. 01-1505L at no. 12 Nwamba Street Achara layout Enugu.
- Jinno sachet water(Sample E) produced by Jinno ventures near St. Mary's hospital Abakpa Nike, Enugu, NAFDAC Reg. No. 01-1641L.
- **Conductivity Meter:** It was used in ascertaining the temperature and Electrical conductivity of a water sample
- **Atomic Adsorption Spectrophotometer (AAS):** It was used in obtaining the absorbance of heavy metals in the water samples.
- **pH Meter:** It was used in obtaining the pH of the water samples
- **Turbidity Meter:** It was used in measuring the turbidity of the water samples.
- **Measuring Cylinder:** It was used in measuring the required amount of water sample needed into beaker or beakers, conical flasks and volumetric flasks for the experiment.
- **Conical Flask:** Water samples and other solutions used for the study were poured into it during the experiment.

- **Volumetric Flask:** It wasused to mix some laboratory reagents.
- **Burette**: It contained the diluted acid or base required to be used for the titration.
- **Beaker**: It contained the required amount of water sample needed for the experiment
- **String**: It was used to measure the required amount of reagent needed to be put into the water sample.
- **Filter paper:** It was used in filtering of the water sample.
- **Funnel**: It was used in filtering of the water sample.
- **Oven**: It was used to heating

METHODS

Analysis of the Water Samples

Samples were randomly collected from the production plants at the three councils that make up Enugu urban and were taken to the water quality laboratory of Enugu State Water Co-operation, Quality Control Unit 3, Constitution Road G. R. A. Enugu, Enugu State for analysis.

Determination of Temperature

Freshly produced sachet water samples was collected from the companies and taken to the laboratory for their temperature analysis within 24 hours of production to avoid contaminations. The conductivity meter was switched on and zero error was corrected, prior to this, the electrode was inserted into 250 ml beakers containing the water samples.The system was allowed to stabilize and the temperature reading was recorded.

pH (Potential Hydrogen) Determination

The water samples were put into 250 mL beaker then pH meter was inserted into them for pH measurement. The water sample was allowed to stabilize and readings were recorded.

Electrical Conductivity (Ec)

The electrode was well wetted and then plugged into the conductivity meter before inserting it into 250 mL beakers containing the water samples. The conductivity meter was switched on and zero error was corrected, the system was allowed to stabilize and the readings were recorded.

Turbidity

The turbid meter was switched on, and one covert was filled with distilled water to a mark used to standardize the meter. Covet containing distilled water was later replaced with another containing water sample to be analyzed, the sample was allowed to stabilize and its reading was taken.

Alkalinity

This was determined following the standard method proposed by APHA (1992). 10 mL of water sample was pipette into a conical flask and three drops of methyl orange indicator was added and titrated with 0.1N HCl,a color change from yellow to orange was observed. Equation 1 was used for calculation of alkalinity content of the samples.

$$Total\ Alkalinity = \frac{Vol.\ of\ H_{2SO_4}(v1)XNX\ 50\ X\ 1000}{Vol.of sampletaken\ (V2)} \quad (1)$$

Where:

V1 = Vol. of H_2SO_4, N = Normality of the acid (HCl)

TOTAL HARDNESS DETERMINATION

50 mL of sample was pipette into a conical flask 2 mL of buffer and 1 mL of eriot T indicator was added to the sample the color turns reddish. It was further titrated with 0.01M EDTA the color changes to blue.

DETERMINATION OF COPPER (CU)

10 mL of the digested sample into 50 mL of volumetric flash 10 mL of 0.01N NH_4OH was added. This was made up to the mark with distilled water. The absorbance was read from the Atomic Absorption Spectrophotometer at wavelength of 620mm. Equation 2 was used to calculate the concentration of copper in the solution.

$$Copper = \frac{Conc.X\ 1000}{10}\ mg/L \quad (2)$$

Determination of Lead

10 mL of the water sample was measured into a volumetric flask and 5 to 6 drops of 10% potassium cyanide was added together with 25 mL of 1:2 ammonium solution and 0.5ml of 10% $NaS0_4$ (Sodium Sulphate). This was made up to 50 mL with distilled water. Lead (Pb) was measured at the wave length of 430 nm. However, equation 3 was used for conversion of the AAS readings.

$$Lead = \frac{Conc.\ X\ DF\ X\ 1000}{1000\ X\ Vol.of\ water\ sample}\ mg/L \quad (3)$$

DF (Dilution fraction) = 50/10 = 5

Determination of Chloride

50 mL of water sample is added in a conical flask. After which 2 drops of 0.1N $K_2\ Cr_2\ 0_7$was added to the solution and silver nitrate was titrated into the conical flask. Thereafter, a change in color from yellow to red was observed. Thus, equation 4 was used for calculation of the calcium content of the water samples.

$$\text{Chloride} = \frac{Tv\ X\ N\ X\ 35.5\ X\ 1000}{Vol.of\ water\ sample}\ mg/L \quad (4)$$

Tv = Titre value

N = Normality of $K_2\ Cr_2\ 0_7$

Determination of Iron

Iron (Fe) was determined using Atomic Adsorption Spectrophotometer. 10 mL of water sample was pipette into 100 mL volumetric flask. In a similar manner,1 mL of hydroxylamine hydrochloride (10%) was added into the volumetric flask containing 50 mL of distilled water. More so, 10 mL of 0.25% 0-phenanthroline also was added. The mixture was made up to 100 mL mark andStoppard and shaken thoroughly and allowed to stand for 15 minutes. Absorbance was read off using spectrophotometer wave length having been set to 510nmi.e.wavelengths for Fe. The quantity of Fe found in the water samples were determined using equation 5.

$$Iron\ content = \frac{Conc.\ X\ DF\ X\ 1000}{Vol.of\ water\ sample}\ mg/L \quad (5)$$

DF =Dilution factor

Determination of Sulphate in the Samples

Determination of sulphate was carried out by measuring 25 mL of the sample into a beaker and 5 mL conditioning reagent of 0.2g of $Bacl_2$was added and stirred vigorously with a magnetic stirrer for a minute, the mixture was allowed to stand for 4 minutes and the absorbance was read at 425 nm wave length using AAS. However, sulphate content of the water samples was calculated using equation 6.

$$Sulphate = 305.39X - 0.3809 \quad (6)$$

X = absorbent value

Determination of Magnesium and Calcium

20 mL of the water sample was measured into a beaker 0.03g or a pinch of potassium cyanide, 0.03g or a pinch of hydroxylamine hydrochloride, 5ml of buffer solution and 3 drops of Eript T was added to the solution. Furthermore, 0.01m EDTA was titrated to the solution until blue black color was seen. Equation 7 was adopted for calculation of the magnesium content of the water samples.

$$Calcium/Magnesium = \frac{Tv\ X\ 0.2432\ X\ 1000\ X\ 1.66}{Vol.of\ water\ sample} \quad (7)$$

Determination of Phosphorus

Determination of phosphorus content of the samples was achieved by measuring 10 mL of the neutralized sample into 50 mL volumetric flask and 4 mL of 10N sulphuric acid added to it,the solution was shook on addition of 6 drops of stannous chloride. Afterwards, distilled water was added to the solution to make it up to 50 mL. Absorbent was read with a spectrophotometer at a wave length of 650 nm. Equation 8 was adopted in determination of the phosphorus content of the samples.

$$\text{Phosphorous} = \frac{Conc.\ X\ DF\ X\ 1000}{Vol.of\ sample} \quad (8)$$

Determination f Zinc

Zinc was determined by measuring 20 mL of water sample into a conical flask, 2 mL of buffer solution, 2 drops of Eriochrome black T indicator were added and the sample turned red. The solutionwas titrated with 0.01m EDTA solution until the solution turned blue. Nonetheless, equation 9 was used to obtain the zinc content of the samples.1ml of ETDA = 0.6538 mg Zn

$$Zinc = \frac{Tv\ X\ 0.6538\ X\ 100\ X\ 250}{Vol.of\ solution} \quad (9)$$

Determination of Total Amount of Dissolved Solid

Empty beaker was washed and dried in an oven. Weight of the empty beaker and filter paper was noted. Furthermore, 10 mL of water sample was poured into the filter paper that is been placed in a funnel and beaker, it was filtered, the filter paper and beaker were put in an oven to dry. The weight of the filter paper and the beaker were measured again. The quantities of dissolved solid in the samples were obtained using equation 10.

$$Dissolved\ solid = \frac{Wt_f - Wt_i\ X\ 1000}{Vol.of\ sample} \quad (10)$$

Where:

Wt_f = Final weight of the beaker

Wt_i = Initial weight of beaker

Determination of Suspended Solid and Total Suspended Solid

The procedure used for determination of dissolved solid was adopted for determination of suspended solid in the water samples. However, total suspended solid was determined according to standard method (2005), 2540D and US EPA (1983) as given in equation 11.

$$TSS\ (\frac{mg}{L}) = \frac{(w_2 - w_1)\ X\ 1000}{V} \quad (11)$$

Where:

W_1 = Weight of clean filter paper (g), W_2 = Weight of clean filter paper plus residue (g)

W = Weight of residue alone (g), V = Vol. of sample (mL)

Determination of Total Solid

Total solid in the water samples was determined by addition of the values ofthe amount of dissolved solid and suspended as expressed in equation 12.

$$T.S = (T.D.S + T.S.S)mg/L \quad (12)$$

BACTERIOLOGICAL ANALYSIS

PlateoOr Colony Count

This was determined using sterile pipette. 1 mL of water sample was delivered into a sterile Petri dish and 20 mL of nutrient agar that was melted and cooled to 45ºC was poured into the dish. The content (water sample and nutrient agar) of the dish were carefully mixed together. The mixture was allowed to set (solidity) and the Petridish was incubated at 35ºC for 24 hours and the number of colonies of bacteria formed were counted using colony counter.

Determination of Total Coli Form

The method adopted here is known as presumptive Coli forrn test. This method was used to test the water samples to ascertain if there is presence of Coli form organisms in them. It is a best method of detecting the presence of microbiological organisms in water. If a presumptive test is negative, the water samples tested are considered microbiologically safe and will require no further testing. Media (Mac Conkey broth) were distributed into culture tubes containing inverted Durham tubes each containing 10 mL of the media double or single strength. The tubes with the medics were covered with cotton wool and sterilized in an autoclave at 121ºC for 15 minutes. Thereafter, five tubes containing 10 mL of double strength broth and another five tubes containing 10 mL of single strength broth were inoculated with 10 mL, 5 mL and 1 mL of water sample. The mixture of the sample and media were incubated for 48 hours and the culture tubes were examined for gas or evidence of fermentation. The tubes in which gas or evidence of fermentation occurred were noted and marked as positive (+ve) while tubes without evidence of fermentation were negative (-ve). The probable organisms found were noted by referring to the Mac Cready's table for MPN index.

Determination of E- Coli

Sequel to the coli form test, the positive presumptive tube was picked and a portion of it inoculated into a fresh broth. This was incubated in a water bath at 45ºC for 24 hours. At the time of the incubation period, the Durham's tube was checked for gas or evidence of fermentation. Presence of trap red gas is an evidence of fermentation indicating positive result while reverse indicates negative result.

RESULTS AND DISCUSSION

Result of the Physical Contaminants

Table 1 presents the results obtained for some physical tests conducted on the selected sachet water in Enugu metropolis for the study.

Table 1: Result of the physical analysis for the sachet water samples

Test / Unit	Sample A	Sample B	Sample C	Sample D	Sample E	WHO Std.	NSDWQ Std.	Remark
Turbidity (NTU)	Nil	Nil	Nil	Nil	Nil	5.00	5.00	Not turbid
Total solid (mg/L)	86.19	109.49	115.34	133.01	140.12	1000	1000	Normal
T.D.S (mg/L)	86.19	109.49	115.34	133.01	140.12	500	500	Normal
EC (µs/cm$^{3)}$	97.10	60.80	146.2	132.40	150.30	400	400	Normal
Total hardness (mg/L)	Nil	Nil	Nil	Nil	Nil	100- 200	200	Not hard
T.S.S (mg/L)	00	00	00	00	00	500	500	Normal
pH	7.00	7.00	7.00	6.90	7.00	6.5– 8.5	6.5– 8.5	Adequate
Alkalinity (mg/L)	50	50	50	50	50	100	100	Adequate
Temperature (ºC)	26.70	26.80	26.70	26.90	27.00	28	Ambient	Normal

Table 1, the results obtained for the physical contaminants revealed that all the physical parameters were found to be within the acceptable range stipulated by the two standards (WHO, 2008 and NSDWQ, 2007) adopted for the study. However, this can be attributed to the source of water used for production of the sachet waters. The pH of all the tested water samples was found between 6.90 and 7.00; these are within the range stipulated by the two standards used. All the water samples have their pH to be 7 with exception of sample D, Andex sachet water which has its pH to be 6.90, a little bit lower than the neutral level. Its pH level is as well within the range stipulated by the two standards used. Turbidity, total suspended solid and total hardness were not detected in the water samples investigated. Turbidity of water depends on the quantity of solid matter present in suspended state. Hence, turbidity and total suspended solid for all the samples were zero.EC and alkalinity were found within acceptable range stipulated by the standards adopted for the study. However, there were some quantities of dissolved solids found in the samples but they were below the allowable limits stipulated by the standards used. Total dissolved solid obtained were below 500 mg/L for all the water samples. The water samples under studied were not highly mineralized because the TDS obtained for the samples were found between 86.19 and 140.12 mg/L. EC values obtained were between 60.80 and 150.30, thus, the results of the EC of the water samples is an indication that the water was not considerably ionized. This is in line with the results obtained by Yirdaw and Bamlaku (2016).

Table 2: Results of the chemical analysis of the studied sachet water samples

Test/ Unit	Sample A	Sample B	Sample C	Sample D	Sample E	WHO Std.	NSDWQ Std.	Remark
Cu (mg/L)	0.00	0.246	0.755	0.00	0.423	1.3	1.3	Normal
Fe (mg/L)	0.017	0.026	0.034	0.043	0.024	0.3	0.3	Normal
Lead (mg/L)	0.00024	0.00015	0.00033	0.00064	0.00052	0.01	0.01	insignificant
Chloride (mg/L)	35.50	56.80	71.00	73.20	75.00	250	250	Normal
Sulphate (mg/L)	38.51	39.80	31.41	40.50	45.00	250	100	Adequate
Calcium (mg/L)	12.11	12.11	12.11	19.20	20.00	75	100-200	Adequate
Magnesium (mg/L)	12.11	12.11	12.11	19.20	20.00	50	100-200	Adequate
Phosphorus (mg/L)	0.056	0.051	0.077	0.065	0.081	Not >5	-	Normal
Zinc (mg/L	Nil	Nil	Ni	Nil	Nil	3	3	Not found

Copper is one of the heavy metals that are capable of impairing, mostly when consumed above the required dosage. According to WHO and NSDWQ standard, concentration of Cu should not exceed 1.3 mg/L in drinking water. Result of the study conformed to the stipulated standard by WHO and NSDWQ as the Cu contents in all the samples were between 0.00 mg/L and 0.755 mg/L.Pb, one of the four most dangerous heavy metals was found in all the samples but in a very minute quantity. It was obtained between the ranges of 0.00015 mg/L and 0.00064 mg/L. Parks sachet water has the lowest concentration of Pb while Andex has the highest concentration of Pb of all the five sachet waters used for the study. However, the concentrations chemical contaminants were within the stipulated standards by WHO and NSDWQ as shown in Table 2. According to WHO and NSDWQ standards, concentration of chloride should not exceed 250 mg/L. The studied sachet water samples have chloride value rangeof35.50 mg/Lto 75.00 mg/L which is within the limits stipulated by the standards. The WHO has established250 mg/L while NSDWQ established 100 mg/L as the highest desirable limit of sulfate in drinking water. Nonetheless, the sulphate concentrations in all the water samples tested were between 31.41 mg/L and 45.00 mg/L which were found within the safe allowable limit.WHO (2011) standards permissible range for calcium in drinking water is 75 mg/L. Results of the study showed that Ca concentration ranged from 12.11mg/L and 20.00mg/L. Magnesium gave a similar result for the under studied sachet waters. Permissible limit for Mg in drinking water is 50 mg/L and the study's results were within the established standards by the two bodies. Phosphorus contents of the water samples were between 0.051mg/L and 0.081 mg/L. These were within the limits established by WHO as shown in Table 2. The five sachet waters used for the study showed zero concentration of zinc. Nevertheless, all the chemical parameters tested for the study were found within the safe allowable limit for drinking water purpose and it is in line with the study conducted by Chiwetalu (2021).

Table 3: The results of the biological contaminants

Test	Sample A	Sample B	Sample C	Sample D	Sample E	WHO Standard	NSDW Standard	Remark
Total Plate count (CFU/mL)	00	00	00	00	00	100.00	100.00	Adequate
Total coli form(CFU/mL)	00	00	00	00	00	3.00	10.00	Adequate
E.coli (CFU/mL)	00	00	00	00	00	00 per100 ml	00 per100 ml	Adequate

The study revealed that the total plate count for the samples were zero, Total coli form and E. coli were also not found in the water samples used for the study. It therefore indicates that the water samples contain no pathogens.A similar result was obtained by Egwari et al. (2005) in Lagos, South West of Nigeria who in their bacteriology study of sachet water found no Enteric pathogens and Entamoeba coli. More so, Ekwunife *et al.* (2010) carried out a similar study in Awka, South Eastern Nigeria, and no protozoan parasites were detected in sachet drinking water used for their study. However, Alli *et al.(*2011) observed occurrence of parasites in some sampled sachet water in the South West of Nigeria.

CONCLUSION

On the basis of findings, the study established that all the physico-chemicalparameters tested in the selected sachet water produced in Enugu metropolis are consistent with World Health Organization standard for drinking water (WHO,2011) and Nigeria Standard for Drinking Water Quality (NSDWQ, 2007). It is also evident that the values of lead (Pb), Iron (Fe), phosphorus(P), zinc (Zn), calcium (Ca), magnesium (Mg), chloride (Cl) andSulphate (SO_4) fall under the permissible limit and therewere no toxicity problem associated with the sachet water sample. Water samples showed no extreme variations in the concentrations of cations andanions. In addition, bacteriological examinations of the water samples were carried out to ascertain if the sachet waters were safe for drinking. The study revealed that all the sachet water used for the study contained no fecal coli form, E coli and Pathogens. Therefore, these sachet waters assessed were found safe for drinking purposes. Nonetheless, it is important to investigate other source of contamination like radiological contaminants and as well carry out these examinations on other brands of sachet water consumed in the city. Lastly, investigation on the quality parameters for all the vended pure water in Enugu metropolis from time to time will help in quality control for improved livelihood in the city.

DECLARATION OF CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of their work

ACKNOWLEDGMENTS

The authors would like to thank the Water Quality Laboratory of Enugu State Water Co-operation, Quality Control Unit 3 at Constitution Road GRA Enugu, Enugu State for the assistance rendered. Authors'appreciation is also extended to all the referenced authors in this study for the valuable information provided in their research work.

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