E-ISSN: 2709-9423
P-ISSN: 2709-9415
JRC 2022; 3(2): 53-57

www.chemistryjournal.net
Received: 26-06-2022
Accepted: 02-08-2022

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Physicochemical investigation of sachet water quality consumed in Wukari local government, Taraba state, Nigeria

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Abstract
Sachet water has become the predominant source of drinking water in many developing countries and the quality of water drinking should be constantly evaluated for sake of public health. The study was conducted to determine physicochemical parameters of six brands sachet water consumed in wukari, Taraba state Nigeria. The physicochemical results of analyzed water samples revealed that pH, Electrical conductivity, Total dissolved Solid, Turbidity, Dissolved Oxygen, Chloride and Nitrate ranged from 6.4-7.3, 299.86-473.7 µS/cm, 179.915-284.2 mg/L, 2.62-4.73 mg/L, 4.225-5.925 mg/L, 11.775-16.675 mg/L and 3.125-5.61 mg/L respectively, all the values of parameter obtained were within acceptable limits of WHO and NSDWQ for drinking water quality guidelines.

Keywords: Physicochemical parameter, sachet water, Drinking water quality standard

Introduction

Potable Water is necessary ingredient for well-being, and it is basic right for all human races on earth (N. Rahmanian *et al.* 2015) [1]. Our body is made up of about 65% of water, consumption of sufficient quantity of water with the high degree of purity is required for physiological function, metabolism and subsistence of healthy life (B.T. Sawere and A. Uwagwue 2016, Udumu A.U and Maria B. Uduma 2014) [6, 7]. Water is well known as the most renewable and natural resource which covers 70% of earth's surface (Abdullahi Y. *et al.*, 2019) [10].

Water pollution occurs in both developed and developing nations across the globe. Fresh water may be polluted by anthropogenic influence or geological substance (Henry Ofosu Addo *et al.*, 2020, S. Sharma and A. Bhattacharyu 2016) [11, 14]. Public health is highly affected by contaminated water, 80% of sickness cases in developing countries are directly connected to poor hygienic measure and lack of access to safe water (Abdu Balluduwiejuah *et al.*,2013) [15]. Polluted water and lack of good sanitation spread many diseases including polio, typhoid, cholera, dysentery, hepatitis A and diarrhea (WHO 2022). The quality of drinking is an observable interest for humanity because it is clearly linked to social welfare (G.B. Ramesh Kumar and G.T. Hemanth 2018) [19].

Sachet water is commonly polyethylene packaged water, manufactured, commercialized as the main source of drinking water in Nigeria and other developing countries due to inadequate supply of public drinking water from water treatment plant, and it is affordable and accessible to the majority of people than bottle water (Omolu ICJ *et al.*, 2010, Jim Wright *et al.*, 2016, Oluwaseunj *et al.*, 2020) [3, 4, 5]. The quality of drinking is an observable interest for humanity because it is clearly linked to social welfare (G.B. Ramesh Kumar and G.T. Hemanth 2018) [20]. By 2025 about 45 nations are predicted to strive with water deficiency related problem which makes approximately 2.7 billion people 34% of world evaluated population. Kenya, Nigeria, Ethiopia, India are the major countries which can deal with water scarcity in the next 25 years, Few largest countries like China currently suffers from persistent water difficulties (Ramesh Kumar Pahade and Neelu Jain 2021) [20]. Provision of purified water is significant to development, prosperity and economic output of any nation (Henry Ofosu Addo *et al.*, 2020) [11].

This study was aimed to examine physicochemical parameters of six brands of sachet water consumed in Wukari local government Taraba state, Nigeria and to assess the quality with national and international guide lines.

2. Materials and Method

2.1 Description of Study Area

Wukari Local Government Area has an area of 4,308 km² on Latitude 7.0878° N and Longitude 6.5010° E. The population of Wukari local government 241, 546 at 2006 census.

Fig 1: Map of Taraba State showing Wukari Local Government Area.

2.2 Sample Collection

Thirty (30) sachet water Samples were collected from six (6) different brands of sachet water manufactures in Wukari local government area Taraba state, stored in an iced cooler and transported to laboratory for analysis immediately

2.3 Physicochemical analysis

2.3.1 Determination of pH

The pH of the sachet water sample was determined using a pH meter calibrated with standard solutions. The reading of each sample was taken after immersing the probe in the sample and holding two minutes to obtain a fixed value. After each sample reading the probe was cleaned with distilled water (APHA 1995) [17].

2.3.2 Determination of Electrical conductivity (EC)

Conductivity was calculated mathematically by the formula in equation (1)

$$EC\ (\mu/cm) = 0.6/DTS \qquad (1)$$

DTS = total dissolved solid

2.3.3 Determination of Total dissolved solid (TDS)

Total dissolved solid was determined by gravimetric analysis. Clean beaker was weighed and recorded as wb_1. 100ml of water sample was filtrated into weighed empty beaker using glass fibre filtered funnel; the beaker containing filtrate was place in an oven at 180 ^{0}c for evaporation process. When total water was evaporated, the beaker was cooled in desiccators, weighed and recorded as wb_2 (APHA 1995) [17]. The total dissolved solid value was obtained by shown formula in equation (2).

$$TDS\ (mg/l) = \frac{wb2 - wb1}{Ks} \times 1000 \qquad (2)$$

Wb_1= weight of empty beaker before filtration
Wb_2 = weight of beaker after evaporation
K_s = Volume of water sample

2.3.4 Determination of Chlorine

A 100ml of the water sample was transferred into a 250ml conical flask and 3 drops of potassium dichromate indicator was added to the contents of the flask. The resulting mixture in the conical flask was titrated against standard solution of silver nitrate solution to the end point which was indicated by a permanent red color (APHA 1995, Folorunso Femi Adekunle *et al*., 2020) [17, 23]. The concentration of chloride in sample can be calculated by formula shown in equation

$$Chloride\ (mg/l) = \frac{[V1 - V2] \times N \times 35.45}{VS} \times 1000 \qquad (3)$$

V_1 = Volume of Silver nitrate ($AgNO_3$) solution required for sample
V_2= Volume of silver nitrate ($AgNO_3$) solution required for blank
V_S = volume of sample
N= Normality of silver nitrate ($AgNO_3$) used

2.3.5 Determination of Dissolved Oxygen (DO)

Dissolved oxygen was estimated by titration method; 2ml of Manganese Sulphates and 2ml of alkali iodide azide was transferred into BOD bottle containing water sample. The solution was mixed well, allowed to settle and then Concentrated Sulphuric acid was added. The prepared sample solution was titrated against 0.025N of Sodium thiosulphate using 1ml of 1% starch solution as an indicator which gave blue –black colour the end point was achieved by disappearance of blue –black to colorless. By considering 1ml of 0.025N of sodium thiosulphate requires 0.2 mg of oxygen (APHA 1995) [17]. The concentration of dissolved oxygen was determined using equation (4).

$$D.O\ (mg/l) = 0.2 \times V_N \times V_S \times 1000 \qquad (4)$$

V_N = Volume of sodium thiosulphate used
V_S = volume of sample used

2.3.6 Determination of Turbidity

Turbidity was measured using Nephelometric method which is based on comprising of the intensity of light scattered by a standard reference suspension under identical conditions. The intensity of scattered light is directly proportional to the turbidity; turbidity meter is equipped with tungsten filament lamp as a light source for illuminating the water sample inside transparent glass tube and a detector with read out device which is used in measuring the turbidity value by turbidity meter (APHA 1995) [17].

2.3.7 Determination of nitrate

1omL of water sample was transferred into a 50mL volumetric flask, 10 mL of 13 N Sulphuric acid was added and shaken with swirling, and the flask was placed on ice water bath for cooling. 0.5 mL of brocine sulfanilic was added and diluted to the mark with distilled water, and solution was warned on 100 ^{0}C boiling water bath for about 25 minutes for maximum colour appearance, the flask was cooled to moderate temperature (25 ^{0}C). The absorbance was measured at 410nm wavelength (APHA 1995, Sa'id, M.D and Mahmud, A.M. 2013) [17].

Table1: Physicochemical parameter of water Samples with national and international standard

Parameter	Sample ID						Standard	
	1SW	2SW	3SW	4SW	5SW	6SW	WHO	NSDWQ
Ph	6.7	6.4	7.5	6.45	6.65	7. 3	6.5 –8.5	6.5-8.5
EC (µS/cm)	308.60	457.30	473.70	398.95	299.86	352.02	000	1000
TDS (mg/L)	185.160	274.4	284.20	239.30	179.915	211.20	500	500
Turbidity (NTU)	3.73	4.84	3.72	3.03	2.62	4.73	5	5
DO (mg/L)	5.885	5.925	5.895	5.025	4.83	4.225	≤7	5
Chloride (mg/L)	8.775	8.975	16.675	12.635	11.775	14.32	250	200
Nitrate (mg/L)	4.625	3.82	3.125	4.825	4.81	5.61	50	50

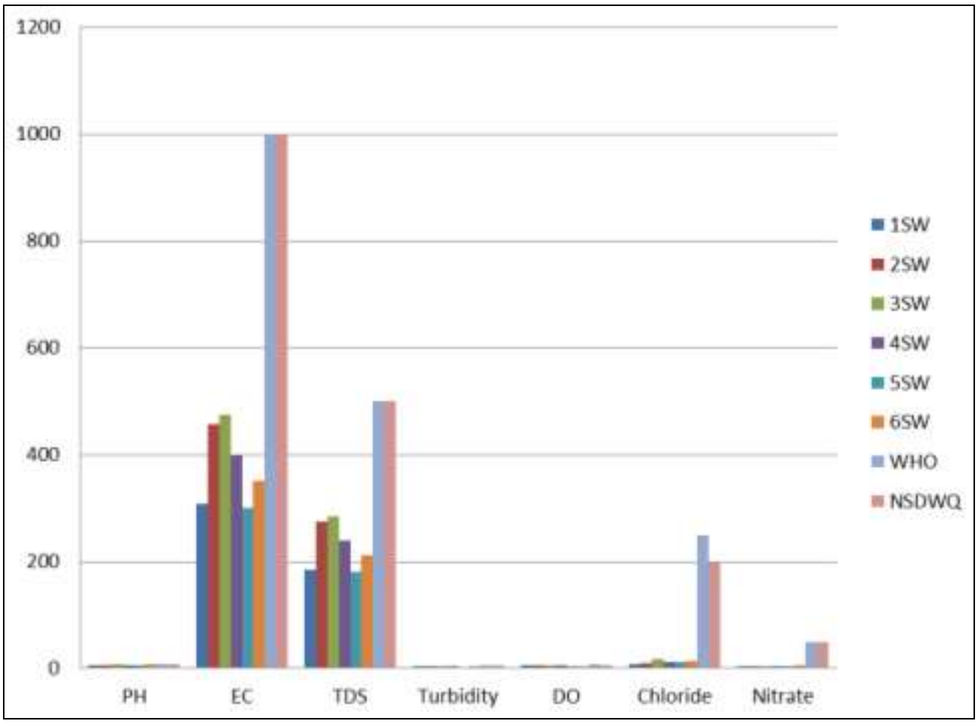

Fig 1: physicochemical parameter of water samples with international and national standard

Result and Discussion

Table 1 and figure1 have shown the result of analyzed six brands sachet water samples.

pH

The pH values of the samples had the range of 6.4 - 7.3; the highest pH value was observed in 6SW while 2SW had the lowest value of pH. The pH values of the entire water samples were within permissible value (6.5-8.5) set by world health organization (WHO) and Nigerian standard for drinking water quality (NSDWQ) which is safe for drinking. Lowest and highest pH values apart from world health organization permissible values alter the taste of water to bitter which causes potential health effects of water.

Electrical conductivity (EC)

Electrical conductivity of all the samples were within world health organization and Nigerian standard for drinking water quality value 1000 µS/cm as shown in table 1 and figure 1. The electrical conductivity of the samples were between 299.86 and 4.73.70 µS/cm. The sample 5SW had lowest electrical conductivity value while the highest value was observed in 2SW. Electrical conductivity is directly proportional to total dissolved solid in water sample as demonstrated in equation1. Electrical conductivity indicates the presence of ions of chloride, sulphate, nitrate, carbonate, bicarbonates, magnesium and sodium, potassium in water (Folorunso Femi Adekunle *et al*., 2020) [23]. The higher concentration of inorganic ions in water samples the higher electrical conductivity value. Consumption of water with electrical conductivity value of less than 40 µs/cm for long period of time is linked to health challenges such as pregnancy disorder, diuresis, higher likelihood of fracture in children, low baby weight at birth and propagated tooth decay (WHO 2017, Mustapha D. Ibrahim *et al*., 2015) [25, 26].

Total dissolved solid (TDS)

The total dissolved solid values in the samples were in the range of 179.915-384.20 mg/L, the 2SW sample has highest value of total dissolved solid and lowest value was observed in the 5SW as presented in table1. The total dissolved of analyzed samples were within the world health organization(WHO) and Nigerian standard for drinking quality(NSDWQ) standard of 500 mg/L. the higher values exceeding the standard value cause diseases including heart disease, hypertension, ischemic, heart, goiter. Water with higher values than standard limits reveals bad Odour or taste (Folorunso Femi Adekunle *et al*., 2020) [23].

Turbidity

Turbidity of all water samples did not exceed the permissible value of 50 NTU. Turbidity is greatly functional parameter which rapidly, economically and proportionally indicates the presence of chemical and biological substances in drinking water, higher value of turbidity above standard value in filtered water can show insufficient removal of microorganisms and chemical contaminants, and this may likely be linked to various outbreaks of diseases (WHO 2017) [26].

Dissolved Oxygen

Dissolved oxygen of the analyzed samples were between 4.225 sMG/L and 5.925 mg/L as displayed in Table 1, 6S W had the lowest value of dissolved oxygen and highest value is shown in 2SW which were within the accepted value of standard for drinking water. Permissible value of dissolved oxygen is essential for drinking water quality (Manoj Kumar and Avinash Puri 2012) [27].

Chloride

The amount of chloride in all evaluated samples were within acceptable values of WHO (200 mg/L) and NSDWQ (250 mg/L) as illustrated in table 1. Chlorine is commonly used in the process of water disinfection except production of harmful byproducts makes it questionable, various studies have been carried out to investigate its adverse effects on consumers and discovered that elevated concentration causes abdominal pain as well as bonding with organic compounds in the water to form chlorinated organic compounds which may cause cancers (Zaid B. Hameed *et al*., 2020 [28,], Janika Lehtonen *et al*., 2019) [29].

Nitrate

The concentration of Nitrate of studied samples were within the range of 3.125 mg/L-5.61 mg/L, the highest concentration of Nitrate was observed in 6SW sample while 3SW showed lowest concentration of Nitrate ion. All the samples were within the acceptable concentration set by standard as demonstrated in Table1. Concentration of nitrate higher than permissible concentration of 50 mg/L in drinking water causes children blueness disease known as Methaemogloinaema, neural tube defects and cancer diseases including thyroid cancer, colon, stomach, bladder and breast cancer (Sunday Adewale Akintelu *et al*.,2021, Zaid B. Hameed *et al*., 2020, Mary H. Ward *et al*., 2018) [24, 28, 30]

Conclusion

All physicochemical parameters of sachet water samples including pH, EC, Total dissolved solid, Turbidity, Dissolved oxygen, Chloride and Nitrate were within permissible limits of WHO and NSDWQ for standard water quality guideline**.**

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