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Physicochemical Parameter of Some Sachet Water Samples in Kazaure Metropolis, Jigawa State, Nigeria

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Abstract
This study presents the result of quality assessment of some sachet water sold in Kazaure metropolis. Five different brands of sachet water were sampled, physically examined and assessed for their physicochemical parameters using standard analytical procedures to ascertain the level of compliance with World Health Organization (WHO) and Standard Organization of Nigeria (SON) specification for drinking water. The results from the physical examinations reveals that none of the water brands indicated the mineral composition, manufacturing date, expiry date and batch number, while all the water brands had product name, manufacturers address and NAFDAC number. Furthermore, result from physical analyses showed that total dissolved solid ranged from 46.0 – 128.0mg/l, conductivity ranged from 92.0 – 251.0μS/cm, temperature ranged from 25.6 – 27.1℃, total suspended solid and turbidity were found to be 0mg/l. Results from chemical analyses show that all the samples have pH range of 6.4 – 7.2, calcium range from 3.60 – 7.210mg/l, chloride range from 7.0 – 11.340mg/l, magnesium range from 0.40 – 4.790mg/l, total hardness range from 4.0 – 12.0mg/l, and total alkalinity range from 15 - 250mg/l.The results of both physical and chemical analyses support the conclusions that, the pH, electric conductivity, temperature, total dissolved solid, total suspended solid, turbidity, hardness, chloride, calcium, magnesium and alkalinity of this study are within the acceptable limits set by WHO and SON for safe drinking water. Therefore, sachet drinking water in Kazaure metropolis is safe for consumption.

Keywords: Kazaure Metropolis, Physicochemical, Sachet water, Water

INTRODUCTION
Water is one of the essential commodities needed by all forms of life in ecosystem. It is the most abundant in the earth crust (about 75%). Despite its relative abundance, good quality drinking water is not readily available to man (Onweluzo and Akuagbazie, 2010). Sachet packaged drinking water is very common in Nigeria. It is often found as a major source of water at food canteens and sold by many food vendors in the country (Adiotomre and Agbale, 2015). The non- availability of good quality drinking water has resulted in number of health challenges as water is known to be a primary causative agent of many contagious diseases. In developing countries of the world, 80% of all diseases and over 30% of deaths are related to drinking water (Olaoye and Onilude, 2009; Onweluzo and Akuagbazie, 2010). This gives chance to private individuals to invest in the production of packaged drinking water (Dada, 2009). Sachet water can be referred to as ready to drink packed and machine-sealed water. This water is referred to as "pure water" by many of the locals in Nigeria and other African

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neighbouring countries like Ghana, Niger, Benin Togo etc (Adiotomre and Agbale, 2015). The main source of sachet water is water from borehole, springs, taps etc. Sachet water produced in small scale industries is mainly treated by aeration, double or single filtration using porcelain molecular candle filter or membrane filters and in rare instances, disinfection is applied. The level of treatment generally depends on the source of water.

Water is said to be potable when its physical, chemical and microbiological qualities conform to specified standards (Onweluzo, and Akuagbazie, 2010). According to Federal Ministry of Health Statistics, only about 30% of Nigerians have access to potable water while the United Nations estimated that about 1.2 billion people all over the world lack access to potable water (Oyeku *et al.*, 2001; Ajewole, 2005).

However, physicochemical parameters are parameters that ascertain the quality of water. These parameters comprise the physical which can be access physically like colour, odour, taste, turbidity etc. and chemical parameters that can be determine using chemical test, e.g. chloride, alkalinity, free carbon dioxide, calcium, magnesium etc. Some of these parameters can be determine by titrimetric method, while some using highly sensitive equipment like spectrophotometer, atomic absorption spectrometer (AAS) etc.

MATERIALS AND METHODS

Samples

Sample A - Sachet water sample from Yasmeen Table Water Company
Sample B - Sachet water sample from Rabiu Danladi (R.D) Table Water Company
Sample C - Sachet water sample from Babban Rafi Water Company
Sample D - Sachet Water Sample from Mega and Dan Asabe (M.D) Water Company
Sample E - Sachet Water Sample from Amsas Table water Company

Study Area

Sample Collection

The sum of ten samples from five different brands were purchase from the sellers as packaged by the manufacturers and put in a sterile polypropylene sample containers with leak proof lids.

Physical Parameters/Analyses

The analysis was conducted at Challawa water laboratory in Challawa water treatment plant, Kano State.
Physical examination of labeling information of the samples were examined.
The appearance and labels of the water samples were observed

Determination of Temperature

The temperature of all the water samples were determined using a simple mercury-in-glass thermometer calibrated in degrees centigrade.

Total Suspended Solids and Turbidity

The total suspended solids (TSS) content and turbidity of each water sample was determined with hach portable colorimeter (Model DR/890) as described by APHA (1998). The instrument was zeroed with 25ml of deionised water which also served as the blank; afterward the TSS was determined on 25ml of each water sample after 2min vigorous shaking. The instrument was in turn to measure turbidity by pressing "program 95" on the instrument's panel. The meter was zeroed with 10ml of deionised water (blank) and turbidity read directly from the instrument expressed in Nephelometic Turbidity Unit (NTU).

Total Dissolved Solids (TDS)

Total dissolved solids were determined with a TDS meter. The electrode was rinsed with deionised water followed by the water sample. The rinsed electrode was allowed to stabilize in the sample for 1min after which the TDS value was read directly in mg/L.

Conductivity

Conductivity was determined with a conductivity meter as described by APHA (1998). The probe of the instrument was rinsed first with distilled water and following rinsing with each water sample. The probe was allowed to stay in the water sample for 1min before recording the reading in micro siemen per cm (μScm^{-1}).

Chemical Analysis

Determination of pH

The pH was determined using pH comparator by adding 6 drops of bromothymol bleu indicator in 20ml of the sample.

Chloride

Chloride was determined by the silver nitrate titrimetric method as described by APHA (1998). A 100 ml volume of each sample in a conical flask was mixed with 3 drops of 10% potassium chromate indicator and titrated against 0.02N silver nitrate to a reddish tinge end point. Distilled water served as the control (blank). Concentration of chloride was calculated using the expression:

$$Cl\ (mg/L) = \frac{(A\text{-}B) \times N \times 35.45}{\text{Vol. of sample}} \times 1000$$

Where A = Titer value of sample
B = Titer value of distilled water
N = Normality of Silver nitrate

Total Hardness

Total hardness was determined by titrimetric method using ethylenediamine tetra acetic acid (EDTA) as described by APHA (1998). 50ml of each water sample was measured in a 250ml conical flask and mixed with 1ml of NH_4Cl – NH_4OH buffer; small amount of Eriochrome Black T indicator was added and titrate with 1M EDTA to a blue end point. Total hardness was calculated with the expression:

$$\text{Total hardness (mg/L)} = \frac{A \times N \times 1000}{50ml}$$

Where A = Titre value, and N is the Normality of EDTA

Determination of Calcium

50ml of each sample were measured in a conical flask; 2ml of 1.0N NaOH and small amount of meroxide indicator was added and titrate with 1M EDTA APHA (1998). The expression blow is used to express concentration of calcium in mg/L

$$\text{Calcium (mg/l)} = \frac{\text{ml of EDTA} \times N \times 40.08 \times 1000}{\text{ml of sample}}$$

ml of sample = 50ml

Normality of EDTA = 0.1M

Determination of Magnesium

Magnesium was determined by subtracting the result of calcium obtained from that of total hardness

Determination of Alkalinity

Alkalinity was obtained by titrating 100ml of the samples with 0.1M HCl solution using methyl orange as indicator.

$$\text{Total alkalinity (mg/l)} = \frac{\text{ml of HCl} \times N \times 1000 \times 50}{\text{ml of sample}}$$

ml of sample = 100ml

N= Normality of HCl = 5000

All the above procedures is according to American Public Health Association (APHA, 1998)

Results

Table 1: Results of Physical Examination of Sachet Water

Sample	Product Name	Manufacturer Address	Manufacturing Date	Batch Number	Expiry Date	NAFDAC No	Mineral composition
A	+	+	–	–	–	+	–
B	+	+	–	–	–	+	–
C	+	+	–	–	–	+	–
D	+	+	–	–	–	+	–
E	+	+	–	–	–	+	–

+ = Indicated – = Not indicated

Table 2: The Results of Physical Analyses of Sachet Water

Samples	TDS (mg/L)	TSS (mg/L)	Conductivity (μS/cm)	Turbidity (NTU)	Temperature (℃)
A	86.2	0	177.6	0	26.2
B	126.0	0	246.0	0	26.5
C	128.0	0	251.0	0	25.8
D	63.3	0	128.0	0	27.1
E	46.0	0	92.0	0	25.6
WHO	500	0	1000	5	-
SON	500	-	-	-	-
NIS	500	-	1000	5	Ambient

WHO Standard Guidelines (2011), SON Standard Guidelines (2007) and NIS (2007)

Chemical Analyses

Table 3: The Results of Chemical Analyses of Sachet Water

Samples	pH	Chloride (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Total Hardness (mg/L)	Total Alkalinity (mg/L)
A	7.2	7.0	5.40	4.60	10.0	25
B	7.0	10.63	5.40	0.60	6.0	20
C	6.6	11.34	7.21	4.79	12.0	20
D	6.8	7.80	5.40	2.40	8.0	15
E	6.4	7.09	3.60	0.40	4.0	20
WHO	6.5-8.5	250	50	-	100-300	-
SON	6.5-8.5	200	0	-	-	-
NIS	6.5-8.5	250	-	0.2	150	-

WHO Standard Guidelines (2011), SON Standard Guidelines (2007) and NIS (2007)

Discussions

The National Agency for Food, Drug Administration and Control (NAFDAC) requires that all the labelling of food and drugs must be informative and accurate. This information required on labelling include Producers name, Contact information, Batch number, Nutritional information, Expiration date (Best before date), Manufacturing date and NAFDAC registration number (Dada, 2009; Musa *et al*., 2014a).

Table 1 revealed that all the sachet water investigated had 100% compliance in term of the product names, manufacturing addresses, and NAFDAC number. These information are however essential as it tells the consumer whether the water sample is still within it shelf life or not. Moreover, all the sachet water were observed to be without batch number, manufacturing date, expiry date and mineral composition on their labelling. Batch number is essential for any product especially when there is need to recall a product from the market in the event of discovery of any abnormality with the product. The act of non-compliance by the water production factories as truly observed in this present study is a source of great concern as the packaged water sold to the entire public are liable to cause health risk when consumed. It has been reported that significant number of packaged water vendor that resist compliance to best practices laid down by the authorities do not have the license to operate (Ndinwu *et al*., 2008; Olaoye and Onilude, 2009). However, it is not the case with this present study as all the sachet water were duly certified to operate as evident in the NAFDAC registration provided.

The results from table 2 show that all the brands of sachet water were observed to have zero turbidity. This shows that all the sachet water complies with the recommended standard by World Health Organization (WHO). Turbidity in water results from the presence of suspended solids. Therefore, the observed zero turbidity is an indication of zero TSS result.

Temperature is a measure of the average thermal energy of a substance. The temperatures of the sachet water samples were within the range of 25.6 to 27.1℃. The value reported in this study is practically within ambient temperature. Although there was no recommended standard set by World Health Organization (WHO) and Standard Organization of Nigeria (SON).

Electrical conductivity (EC) of sachet water range 92.0 to 251μscm^{-1}. The value of E.C is low compared to the maximum of 1000μscm^{-1} recommended for drinking water by WHO standard. According to (Ndinwa *et al.,* 2012) low E.C value denotes the presence of minimal amount of dissolved salts (mineral elements such as calcium, magnesium and fluoride) in water. The long term drinking of packaged water with E.C value of less than 40μscm^{-1} constitute a number of health risks such as higher probability of fracture in children, pregnancy disorder (preeclampsia), diuresis, premature or low baby weight at birth and increased tooth decay (Guler and Alpalsan 2009).

Total suspended solids (TSS) revealed that all the sachet water has zero total suspended solid (TSS) which is within the recommended Standard recommended by World Health Organization. This result clearly shows that there is no particulate matter present in all packaged water under examination.

Total dissolved solids (TDS) of 46 to 128mg/l were recorded in sachet water. However, TDS of all the water samples was observed to be within the World Health Organization (WHO) and Standard Organization of Nigeria (SON) standards of 500mg/L. Total dissolved solid is

a measure of the level of dissolved solid in water and it influences the taste of drinking water if above the WHO limit of 500mg/L.

The sachet water samples had a pH range of 6.4 -- 7.2. All the water samples analyzed were within the range 6.5 to 8.5 recommended by World Health Organization (WHO), NIS and SON. However, the result shows that all the water samples are safe for consumption. This is also in line with the result obtained by (Usman, 2015), who reported the pH of water sample as 6.0-7.13.

The levels of total hardness range from 4.0 to 12.0mg/L. Moreover, all the brands of sachet water evaluated are within the range of total hardness recommended by WHO and SON. Hardness in drinking water is mainly due to carbonates, bicarbonates, sulphates and chlorides of Ca and Mg. WHO, (2004) and NIS, (2007) classified water that contain less than150mg/l $CaCO_3$ as soft and more than150mg/l $CaCO_3$ as hard. Hence, all the sachet water samples in this study are considered soft.

Chloride ions concentration was determined to vary from 7.0 – 11.34mg/L. The result is appreciably within the WHO and SON guideline value of maximum permissible concentration of 250mg/L and 200mg/L respectively. This limit has been laid down primarily based on taste considerations. However, no adverse health effects on humans have been reported from intake of water containing even higher concentrations of chloride (Ndinwa *et al.,* 2012). But higher concentration of chloride ions in drinking water can add its taste to the water.

The calcium level in all the samples falls within the Range of 3.60 - 7.31mg/L. This range is in line with WHO standard for drinking water. National Research Council (NRC, 1989) noted that calcium is one of the essential dietary minerals that drinking water usually supplies. However, high level of calcium in water causes hardness.

The values of alkalinity vary from 15mg/L - 25mg/L for all the brands of water samples. However, WHO didn't specify any standard with regard to alkalinity. Alkalinity affects water quality in a way that mainly neutralization pH. Alkalinity measurements are used as the means for evaluating the buffering capacity of water.

CONCLUSION

The results obtained are supportive with the conclusions that, Various physio-chemical parameters like hardness, TSS, TDS, alkalinity, turbidity etc were analyzed using standard methods of APHA (1998). All the physicochemical parameters of the sachet water samples analyzed are within the acceptable limits set by WHO (2011) and SON for safe drinking water. However, none of the samples indicate expiry date, batch number, manufacturing date and mineral composition. The water samples can consider safe for drinking, but yet the manufacturers have to improve in the area highlighted above.

RECOMMENDATIONS

It is suggested that regular supervision of sachet water industries by regulatory agencies (NAFDAC, SON and NIS) to ensure the quality of sachet drinking water.

Regulatory agencies should make it necessary that all sachet water companies should have a standard laboratory for analysis of water before and after production. Moreover, the companies should properly label all relative concentrations of all the parameters being analysed.

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