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ASSESSMENT OF PHYSICOCHEMICAL QUALITY OF SACHET WATER PRODUCED IN SELECTED LOCAL GOVERNMENT AREAS OF KANO METROPOLIS, KANO STATE - NIGERIA

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ABSTRACT
Fifty (50) brands of sachet water produced from bore hole and tap water in five (5) local government areas of Kano metropolis were analysed for physicochemical quality. Ten (10) brands of sachet water were sampled from each of the five (5) local government areas of; Nasarawa, Tarauni, Gwale, Kumbotso and Ungogo. Physical parameters tested such as; colour, taste, odour and pH in all (100%) the sachet water samples conformed to the recommended limits. Chemical analysis carried out such as; conductivity, total dissolved solids (TDS), chloride content, fluoride content, nitrate and nitrite content, total hardness and free chlorine all conformed to the requirements of the WHO and NIS standards. Heavy metals tested (using AAS) include; Manganese (Mn), Arsenic (As), Zinc (Zn), Copper (Cu) and Lead (Pb) also conformed to the requirements of the standards. However, Iron (Fe) content in all the sachet water produced from bore hole (twenty three brands (23)(46%)) were observed to be above the recommended NIS limit of 0.3mg/l. It can be concluded from the results of this study that the physicochemical parameters tested in the sachet water samples were within the permissible limits stipulated by the drinking water standards, hence on this basis the water is considered fit for consumption.
Key words; Kano metropolis, Physicochemical quality, Sachet water

INTRODUCTION

Water is one of the most important natural resources known on earth (Ojo *et al*., 2005). Water of good quality is important to human physiology and man's continued existence depends very much on its availability (Lamikanra, 1999). Before water can be described as potable, it has to comply with certain physical, chemical and microbiological standards, which are designed to ensure that the water is potable and safe for drinking. Potable water is defined as water that is free from contaminants, such as disease causing microorganisms and harmful chemical substances (Ihekoronye and Ngoddy, 1985). The importance of potable water supply in the socio-economic life of the public cannot be over emphasized. Often, source and potability of water supply reflects on the health conditions of communities. Water meant for consumption should be free from pollution, acceptable and safe. Indeed the quality of the water sources should not exceed the maximum limits specified in the water quality guidelines (Obi *et al*; 2004). Sachet drinking water was introduced into the Nigerian markets as a less expensive means of accessing drinking water than bottled water (Ogundipe, 2008). There has been countless number of diseases outbreak and poisoning around the world resulting from the consumption of untreated or poorly treated drinking water (Fong *et al*., 2007). Several studies on the quality of sachet water have reported violation of international quality standards. According to the Insitute of Public Analysts of Nigeria (IPAN) 50% of the sachet water sold in the streets of Lagos may not be fit for consumption (Oshibanjo *et al*; 2000). The possibility that the same situation may be applicable to other cities in the country such as Kano metropolis prompted this study.

MATERIALS AND METHODS

Study area

Kano is the largest city in the Sudan region of Nigeria. It comprises of forty four (44) Local Government Areas. Like many sub Saharan African cities, Kano is experiencing very rapid urbanisation, its population has grown from 4,931,789 inhabitants in 1996 to 9,383,682 inhabitants in 2006 (Ahmed, 2009). Kano metropolis (study area) comprises of eight (8) Local Governments; Dala, Fagge, Gwale, Kano Municipal, Nasarawa, Tarauni, Kumbotso and Ungogo. Kano metropolis lies within latitude 11^{o} 52N - 12^{o} 07N and longitude 8^{o} 22E – 8^{o} 07E.

This study was conducted in five (5) local government areas of Kano metropolis, viz; Nasarawa, Tarauni, Ungogo, Gwale and Kumbotso.

Sample Size and Sample Collection

Ten (10) brands of sachet water were sampled from each of the five (5) Local Government Areas of Nasarawa, Tarauni, Gwale, Ungogo and Kumbotso. Three (3) sachets of each brand of the sachet water produced from the bore hole and tap water were sampled from the factories and from the vendors.This gave a total of one hundred and fifty (150) samples. This was repeated on three (3) different times within the months of November to December 2012. A total of four hundred and fifty (450) samples of sachet water were used for this study. The samples were collected in clean coolers and transported to the laboratory where they were stored at room temperature until used.

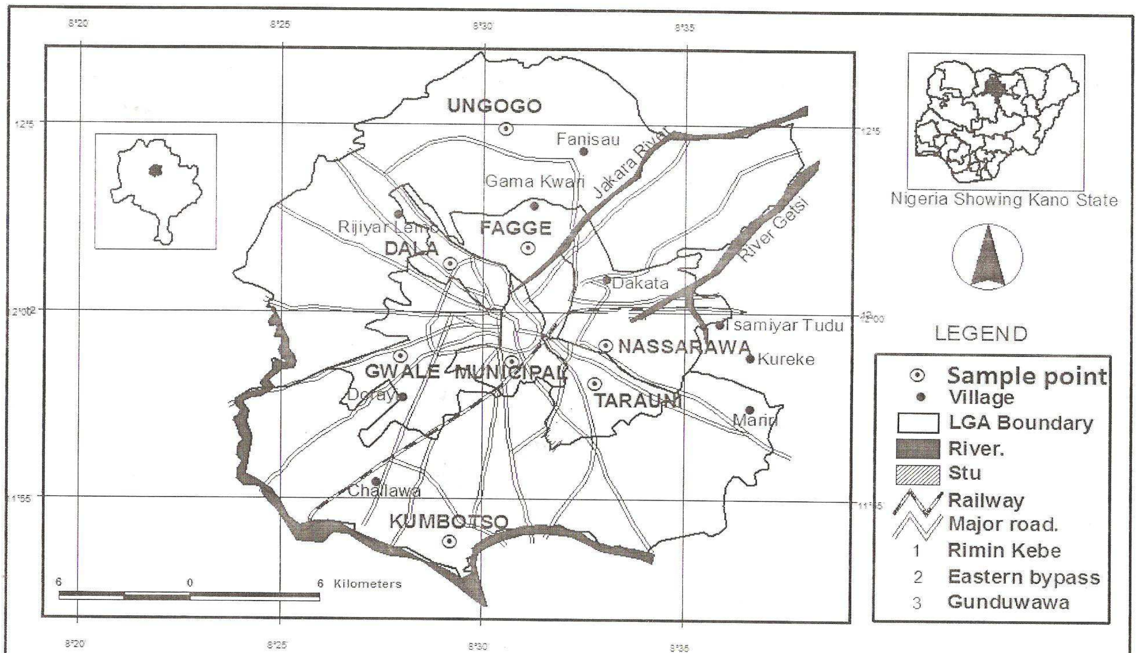

FIG 1: MAP OF KANO SHOWING THE SAMPLING POINTS

Sources: Dept. of Geography BUK (2012)

Physical analysis

Test for colour

The colour of the samples was determined using colour test kit (Lovibon comparator, 2000 visual). One tube of the Lovibond comparator matched tube was filled with the water sample to be examined and the other tube was filled with distilled water used as standard control. Both tubes were placed in the comparator, adjusted by rotating the disc until the nearest colour match was observed. The results was then expressed in whole number and recorded as Hazen unit (Dinrifo *et al*., 2010).

Determination of Temperature

The temperature of all the water samples was determined using a simple mercury-in-glass thermometer calibrated in degrees centigrade as described by Edema *et al*., 2001 and Dinrifo *et al*., 2010.

Determination of Turbidity

Turbidity of all the water samples was determined using turbidometer (HANA instrument HI93703) expressed in whole number as Nephelometric turbidity unit (NTU) as described by other workers (Essien and Olisah, 2010; Dinrifo *et al*., 2010; Olaoluwa *et al*., 2010).

Determination of pH

The pH of the water samples was determined using a pH meter (Toledo, MP220). Each water sample was measured into 100 cm^3 beaker and the pH determined by inserting the pH meter probe after standardization into the beaker and taking the reading. Standardization of the meter was ensured after each reading (AOAC, 2006).

Chemical analysis

Determination of Conductivity

Conductivity of all samples was determined using a digital conductivity meter model 4520 JENWAY, serial No 01263. The meter was switched on and allowed to warm up for about 15 minutes. It was than standardized with 0.01M KCI solution where a conductivity value of 1413 microsiemen per centimetre was obtained, the electrode was thoroughly rinsed with distilled water and then introduced directly into the samples. The value for each sample was taken (Bennet and David, 1974).

Test for Total Hardness

Total hardness of each water sample was determined using a potable UV-visible spectrophotometer (HACH D 89) in which 10 cm^3 of each water sample was pipetted into a sample cell and total hardness reagent H-1K added and allowed to stand for 3 minutes for reaction to take place, after which the total hardness was read (AOAC. 2006).

Test for Nitrate and Nitrite

This was done using a potable UV-visible spectrophotometer (HACH D 89). Two cuvettes were filled with 10 cm^3 of the water sample and the content of nitraver 5 nitrate reagent powder pillow was added in one cell, stoppered and shaken vigorously for 1minute, after which it was allowed to stand for five minutes. An amber colour developed if nitrate was present and for nitrite, nitraver 3 reagent powder was added and allowed to stand for 5minutes, pink colour development is an indication of positive nitrite. Absorbance expressed in mg/l was then measured (AOAC, 2006).

Determination of Total Dissolved Solids

Total dissolved solids (TDS) for each water sample was determined mathematically as a product of conductivity multiplied by a constant value, 0.6 (APHA, 1985).

TDS = conductivity x 0.6

Test for Fluoride

Ten (10) millilitres of each water sample was introduced into dry square sample cell and $2cm^3$ of SPADNS reagent was added and swirl to mix. After a minute reaction time the absorbance of the samples was read from the spectrophotometer (AOAC, 2006).

Determination of Heavy Metals

The following heavy metals; Iron (Fe), Lead (Pb), Copper (Cu), Zinc (Zn), Arsenic (As) and Manganese (Mn), were determined for each water sample using AAS (Buck Scientific, VPG 210) procedure as reported by Oyelola *et al*., 2008 and Olaoluwa *et al.,* 2010.

Each sample was digested using $100cm^3$ and a hallow cathode lamp of the desired metal was installed into the instrument and the wavelength characteristics of that metal was then set. The procedure used flame Atomic absorption spectrophotometry using acetylene/air. Concentrations of the analytes in mg/ml in the digested samples were obtained by extrapolation from the calibration curve prepared by American Public Health Association (APHA, 1985).

Statistical Analysis

The results were statistically analysed using Analysis of variance (ANOVA) operated through SPSS software developed by Microsoft Inc. to determined the variance of the physicochemical parameters of the tap water samples and that of the bore hole water samples.

RESULTS AND DISCUSSION

Physical parameters tested in all the sachet water samples include; colour, odour and taste. These are important quality parameters affecting acceptability of water for consumption (Yakasai *et al*., 2010). All the sachet water samples analysed are clear, colourless, tasteless and odourless. This can be attributed to the use of sand and activated carbon filtration processes used during production in all the sachet water companies.

Conductivity in all the sachet water samples analysed are below the maximum limits of 1000μs/cm stipulated by NIS, 2007 standard. Conductivity values in sachet water produced from tap water ranged between 106 to 266μs/cm while those produced from bore hole water ranged between 18 to 88 μs /cm, this shows a significant difference ($P< 0.001$) between the conductivity of the two water sources. The high conductivity values in tap water compared to bore hole water may be as a result of corrosion, since corrosion of the metallic pipes affects the conductivity of the water (Goodman, 1980). Conductivity value in all the sachet water samples analysed are within the acceptable limit of less than 1000μs/cm stipulated by NIS, 2007 standard. Similar result was reported in the work of Nwosu *et al;* 2004, in which conductivity below 1000μs/cm was recorded in sachet water samples sold in Owerri metropolis.

Total dissolved solids (TDS) of 50 to 166mg/l was recorded in sachet water produced from tap water, while 16 to 24mg/l was recorded in samples produced from bore hole, all the values are within the acceptable limit of 500mg/l stipulated by the NIS, 2007 and WHO, 2004 standards. However, statistical analysis showed a significant difference ($P<0.001$) between the TDS of the two water sources. Nwosu and Ogueke (2004) made a similar observation in sachet water sold in Lagos and Owerri Metropolis respectively.

Total hardness in sachet water produced from bore hole water ranged between 18 to 88mg/l, while a range of 1.0 to 9.2mg/l was recorded in sachet water produced from tap water, these values are within the acceptable limit of 150mg/l required by the NIS, 2007 and WHO, 2004 standards. However, statistical analysis showed a significant difference ($P<0.001$) between the total hardness of the two sources of water. WHO, 2004 and NIS, 2007 classified water that contain less than150 mg/l $CaCO_3$ as soft and more than150mg/l $CaCO_3$ as hard. Hence, all the water samples in this study are considered soft and fit for consumption. This result agreed with the work of Onweluzo and Akuaghazie (2010) in which a total hardness below 6.8mg/ml was obtained for sachet and bottled water sold in Nsukka town, Nigeria.

Other chemical parameters tested such as chloride, fluoride, free chlorine, nitrate and nitrite are all within the acceptable limits of the standards. Statistical analysis of the values obtained for chloride, fluoride, free chlorine and nitrate in bore hole and tap water shown no significant difference ($P>0.05$) between the two water sources, Taiwo *et al*., (2012) reported a similar result for chloride, flouride and nitrate in sachet water samples in Abeokuta, Ogun State, Nigeria.

Heavy metals tested, such as; Manganese (Mn), Zinc (Zn), Copper (Cu), Lead (Pb) and Arsenic (As) in sachet water produced from bore hole and tap water conformed to the requirements of the WHO, 2004 and NIS, 2007 standards. Iron (Fe) content in all the sachet water produced from bore hole (twenty three brands (23)(46%)) were observed to be higher than 0.3mg/l stipulated in the NIS, 2007 standard. High level of Iron (Fe) in water can be attributed to possible dissolution of iron bearing rocks through leaching as the water passes down to the water table. A similar result was reported in the work of Taiwo *et al*., 2012 who reported that some sachet water samples in Abeokuta, Ogun State, Nigeria had traces of Iron (Fe) while others are free of the element. This also conformed to the findings of Asaolu *et al*., 1997, who reported that Iron (Fe) occurred in high concentration in Nigerian soils. Presence of Iron (Fe) in substantial quantity can impact brownish colour to laundered clothings and plumbing fittings, it can also make the water unsuitable for food processing with consequence health hazards (Oyeku *et al*, 2001).

Table 1.0 – Mean Physicochemical Analysis of Sachet Water Sampled from the five (5) L.G.A. of Kano Metropolis

Sample code	Water source	Temperature	PH	Conductivity at 29^{0}c	Total dissolve solids	Chloride content	Fluoride content	Iron content	Nitrite content	Nitrate content	Manganesse	Zine content	Hardness	Free chlorine	Copper	Lead	Arsenic
		Ambient	**6.5 - 8.5**	**1000 µs/cm**	**500 mg/l**	**250 mg/l**	**1.5mg/l**	**0.3mg/l**	**0.2 mg/l**	**50mg/l**	**0.2mg/l**	**3.0mg/l**	**150mg/l**	**0.25mg/l**	**1.0mg/l**	**0.01mg/l**	**0.01mg/l**
N	B/H	20.5	7.5	44	21	27	-	3.0	0.18	5.5	-	0.20	52	-	-	-	-
	Tap	20.6	7.4	66	133	1.4	-	0.21	0.16	13.3	-	0.05	1.6	-	-	-	-
T	B/H	21.4	7.3	37	18	28	-	2.5	0.20	7.5	-	0.11	40	-	-	-	-
	Tap	20.1	7.0	123	65	15	-	0.15	0.20	15.1	-	0.51	1.6	-	-	-	-
G	B/H	21.5	7.4	44	18	25	-	3.5	0.19	8.1	-	0.15	55	-	-	-	-
	Tap	20.2	7.0	113	56	0.2	-	0.11	0.05	9.0	-	0.18	1.5	-	-	-	-
K	B/H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tap	22.5	8.5	160	75	0.6	-	0.17	0.16	7.0	-	0.16	2.3	-	-	-	-
U	B/H	20.5	7.6	27	16	20	-	3.19	0.01	5.4	-	0.03	46	-	-	-	-
	Tap	20.6	7.4	263	13	0.7	-	0.18	0.14	9.3	-	0.22	1.7	-	-	-	-

Key: (-) = Not detected, B/H= Bore hole, G= Gwale, K= Kumbotso, N= Nasarawa, T= Tarauni and U= Ungogo

CONCLUSION AND RECOMMENDATIONS

The assessment of sachet water quality produced in the five (5) Local Government Areas of Kano metropolis, via physicochemical analysis indicated that physical parameters such as appearance, colour, taste and pH conformed to the acceptable standards. Chemical properties such as conductivity, total hardness, nitrate and nitrite, total dissolved solids, fluoride, and heavy metals such as Manganese (Mn), Arsenic (As), zinc (Zn), Copper (Cu), and Lead (Pb) conformed to the requirements of WHO and NIS standards. It can be concluded from the result of this study that the physicochemical parameters tested in all the sachet water samples were within the permissible limits stipulated by the drinking water standards, hence on this basis the water is considered fit for drinking. However, Iron (Fe) content in twenty three brands (23)(46%) of sachet water produced from bore hole were found to be higher than 0.3mg/l stipulated by the NIS 2007 standard. High Iron (Fe) content makes water unsuitable for food processing with consequence health hazards. It is therefore suggested that extensive surveillance of the industry is necessary and more stringent regulations by the regulatory and statutory agencies (NAFDAC and SON) should be developed and enforced to safeguard the health of the people.

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