SPECTROPHOTOMETRIC EVALUATION OF THE CONCENTRATIONS OF NITRATE, NITRITE AND PHOSPHOROUS IN SACHET WATER CONSUMED IN KANO METROPOLIS

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ABSTRACT

Spectrophotometric evaluation of nitrate, nitrite and phosphorous content in sachet water consumed in Kano Metropolis was carried out using powder pillow reagents. The pH and conductivity values were measured by electrometric method. The total dissolved solids were gravimetrically assessed. Titrimetric method was used to determine the total hardness. The organoleptic properties were determined by physical observations. The results of the nitrite, conductivity, dissolved solids and hardness were below the WHO/SON permissible limits. However, some of the pH (4.5-8.5), nitrates and phosphorous values were above the WHO/SON threshold limits. Compliance with drinking water quality standards based on national/international guidelines, should provide assurance that the supply is safe.

Key words: Spectrophotometric, Nitrate, Nitrite, Phosphorous, Methaemoglobinaemia, Kano Metropolis.

INTRODUCTION

Water of suitable purity is indispensable to the human metabolism. The provision of drinking water that is not only safe but also pleasing in appearance, taste and odour is a matter of high priority. Nevertheless, majority of the world’s population (over seven billion) lacks access to safe drinking water, especially in developing countries, including Nigeria (Amoo and Akimbode, 2007).

Drinking water is a vehicle for disease transmission (Degremont, 1991). Many drinking water contaminants including various chemical, physical, microbiological and radiological are known to be hazardous to health (WHO, 1999).
Sachet water is any commercially treated water, manufactured, packaged and distributed for sale, in a sealed food grade containers, and is intended for human consumption (Denloye, 2004). The production of sachet water started in the late 90’s in Nigeria. Today, the advancement in scientific technology has made sachet water production the fastest growing industry in Nigeria. The quality of the water can be evaluated using the WHO, NAFDAC, FEPA, SON and other regulatory agencies guidelines. A guideline value represents the concentration of a constituent that does not result in any significant risk to the health of the consumer over a life time of consumption (WHO, 1999). The problems associated with chemical constituents of drinking water arise primarily from their ability to cause adverse health effects after prolonged periods of exposure, of particular concern are contaminants that have cumulative toxic properties, such as heavy metals and substances that are carcinogenic (DEWO, 1989).

The use of chemical disinfectants in water treatment or construction materials used in water supply system, usually results in the formation of the chemical by-products, some of which are potentially hazardous (ARC, 1987, AWA, 1991). There are number of reported cases of typhoid, diarrhoea and other related water borne diseases arising from consumption of sachet water (Ogamba, 2004).

Nitrate and nitrite are naturally occurring ions that are part of the nitrogen cycle (ISO, 1986). The nitrate ion (NO$_3^-$) is the stable form of combined nitrogen for oxygenated system, although chemically unreactive, it can be reduced by microbial action (NAS, 1981). Nitrate is an etiological factor in human goitre, as it competitively, inhibits iodine uptake (US-EPA, 1987). The nitrite ions (NO$_2^-$) contains nitrogen in a relatively unstable oxidation state, chemical and biological processes can further reduce nitrite to various compounds or oxidize it to nitrate (US-EPA, 1987).

The major biological effect of nitrite in humans is its involvement in the oxidation of normal haemoglobin to methaemoglobin, which is unable to transport oxygen to the tissues (ISO, 1986). The reduced oxygen transport become clinically manifest when methaemoglobin concentration reach 10% to that of haemoglobin and above, the condition called methaemoglobinemia, causes cyanosis and, at higher concentrations asphyxia (WHO, 1986). The normal methaemoglobin level in humans is less than 2% and in infants under 3 months of age less than 3% (NAS, 1981). Nitrite was shown to react with nitrostable compounds in the human stomach to form N-nitroso compounds most of which have been found to be carcinogenic in all animal species tested, so that they are probably also carcinogenic to humans (IARC, 1991).

Phosphorus occurs in natural waters and in waste waters as phosphates. These are classified as orthophosphates, condensed phosphate and organically bound phosphate. Elevated concentrations of phosphorus in water, is an indication of potential health hazards (APHA, 1985). Different works have been reported by many researchers on water quality assessment. Abdullahi (2004) reported the assessment of open well water quality in Sabon-Gari area of Kano State, Ojuekaiye (1998) also reported the determination of total hardness of water in Kano Metropolis, while Gimba (2002) reported the analysis of water quality of selected open shallow wells in Zango Kataf area of Kaduna State and Ihenya (2002) conducted a research on physico-chemical characteristics of well water in Warri Town, Delta State. Safe drinking water should be among the priorities for every nation globally. Today contaminated water kills more people than cancer, AIDS, wars, terrorism or accidents. It is pertinent that the water meant for...
human consumption be free of disease-causing germs and toxic chemicals that pose a serious threat to public health (TWAS, 2002).

However, this study focuses on the spectrophotometric evaluation of the concentrations of nitrate, nitrite and phosphorus in sachet water consumed in Kano Metropolis.

Materials and Methods

Location of the Research: Kano Metropolis with about 3.0 million inhabitants, is located in North-West Nigeria and comprises of six local government areas namely: Nasarawa, Municipal, Tarauni, Dala, Gwale and Fagge. Meteorologically, Kano Metropolis is hot in most time of the year, which makes sachet water business very lucrative.

Sample Collection and Analytical Procedure:

The sachet water samples used in this study were collected in the labelled clean plastic containers during the hot season, when production was at its peak. A total of 25 composite sachet water brands were collected, four from each of the six local government areas investigated. One out of every 20 sachets of a particular brand was sampled. A total of 40 sachets were sampled out of 800 sachets each from all the various brands selected. The 40 sachets were neatly transferred into the labelled homogenization plastic containers and mixed thoroughly to obtain a homogenous sample representative of the entire sampling, from which aliquots were drawn for analysis. The nitrate, nitrite and phosphorus were determined spectrophotometrically at 500nm, 5007nm and 890nm using powder pillow reagents (Hach, 1997). The pH of the sachet water samples were determined using digital pH meter (model Lab Tech. 3320) after the meter had been duly calibrated with standard buffers. The conductivity of the samples was determined using a digital conductivity meter (Model Jen way, 4010). Total dissolved solids (TDS) were estimated gravimetrically. EDTA titration method was used to determine the total hardness, calcium and magnesium, of the sachet water samples. The organoleptic attributes (colour, odour and taste) were analysed by physical observation, using sensory organs.

Fig.1: The Studied Area
Results

The studied areas are shown in Fig. 1. Fig. 2, 3 and 4, show the frequency distribution pattern of the nitrate, nitrite and phosphorous concentrations and are skewed towards high frequency of low concentrations.

The pH of the sachet water (Fig 5.) ranged from 4.2-8.5, indicating acidic, neutral and slightly alkaline. The conductivity of the sachet water (Fig. 6) ranged from 45-374(µs/cm). The TDS distribution of the sachet water (Fig. 7), skewed towards high frequency of low concentration. The total hardness of the samples determined ranged from 22 - 351mg/dm³ (Fig 8).

**Fig. 2: Frequency Distribution Pattern for Concentration of Nitrate in Sachet Water Samples**

**Fig. 3: Frequency Distribution Pattern for Concentration of Nitrite in Sachet Water Samples**
Fig. 3: Frequency Distribution Pattern for Concentration of Nitrite in Sachet Water Samples

![Frequency Distribution Pattern for Concentration of Nitrite in Sachet Water Samples](image)

Fig. 4: Frequency Distribution Pattern for Concentration of Phosphorus in Sachet Water Samples

![Frequency Distribution Pattern for Concentration of Phosphorus in Sachet Water Samples](image)
Fig. 5: Frequency Distribution Pattern for pH in Sachet Water Samples

Fig. 6: Frequency Distribution Pattern for Conductivity of Sachet Water Samples

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Conductivity of Sachet Water Samples (µs/cm)

Concentration of (TDS) in Sachet Water Samples (mg/dm$^{-3}$)
Discussion

The organoleptic evaluation of the sampled sachet water, were tasteless, colourless and odourless. This showed that the sachet water packaged and consumed in Kano Metropolis had good aesthetic value (Denloye, 2004). The nitrate content of the sachet water was below the WHO permissible limits (50mg/dm$^3$), except one sample from Municipal which showed elevated concentration (57.6mg/dm$^3$) above the WHO acceptable limit. Generally, the nitrite contents of the sachet water, was below the WHO threshold limit (3mg/dm$^3$). The low nitrite content was due to the multiple treatment processes involved in packaging sachet water. Four samples showed elevated phosphorus concentrations (0.4272, 0.4468, 0.3590 and 0.6750 mg/dm$^3$) while the rest showed low phosphorus content (0.0033 - 0.2120mg/dm$^3$). The use of sand and industrial filters coupled with coagulating agents during the water treatment processes accounted for elevated concentration of phosphorous in the water.

The pH values obtained showed that twenty of the samples had pH within the WHO acceptable limits (6.5-9.5) while five samples fall below the permissible limits. Low water pH can cause gastro-intestinal irritation especially in sensitive individuals. The conductivity was found to be between 68 to 375µs/cm. All the values were found to be below the maximum permissible limits of 1000µs/cm set by the standard organization of Nigeria (SON) and WHO (Purechem, 2001). The concentration of the total dissolved solid, (Fig.7) was below the permissible limits of (500-1500mg/dm$^3$) set by SON and WHO (Purechem, 2001). Low loaded TDS, imparts flat, insipid
taste to drinking water (Marier et al., 1979). The total hardness levels (Fig.8) were lower than the WHO permissible limit of 100µg/dm$^3$. Drinking water with a hardness less than 75µg/dm$^3$ may have adverse effects on mineral balance in the body (WHO, 1989).

Conclusion

Generally, the nitrate content of the sachet water was low, expect one sample from Municipal. The nitrite concentration in the sachet water was below the WHO threshold limit. Four samples of the phosphorus content showed elevated values, while the remaining 21, was low. Nitrate is an etiological factor in human goitre, as it competitively inhibits iodine uptake. Nitrite in the body causes methaemoglobinemia and eventually death, those most vulnerable are infants under five years. N-nitroso compounds products from nitrite/nitrostable compounds reaction in the human stomach are carcinogenic in animals. Elevated content of phosphorus in water, is an indication of potential health hazards. The contents of the conductivity, TDS and total hardness were below the threshold limits set by SON/WHO. However, the elevated level of pH above WHO/SON permissible limits in some sachet water, pose serious health concern. pH value below the WHO maximum permissible limits (6.5), affects disinfection efficiency and may have an indirect effect on human health. Water is vital to sustain life and a satisfactory supply must be available to consumers.

References


