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# QUALITY ASSESSMENT OF SACHET WATER PACKAGED AROUND KANO METROPOLIS, NIGERIA

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***ABSTRACT***
***Thirty brands of sachet water packaged within Kano metropolis were analysed for physico – chemical characteristics; colour, taste, odour, alkalinity, total hardness, pH, chloride, sodium, potassium, calcium, lead, zinc, chromium, copper, cobalt, nickel and manganese using standard methods. All samples were tasteless, colourless and odourless. The mean pH value fall within the range of 4.68 – 8.81, of which 20% were acidic. Alkalinity and total hardness are within WHO (1983) permissible limit, the value ranged between 3.33 to 31.67 and 0.00 to 66.8 mg/l respectively, except for a sample from site A that has no hardness. The concentration of sodium, potassium and calcium was found to be within the acceptable limit and the chloride of most of the sample (ranging 123 to 166 mg/l) is above the WHO acceptable limit (125mg/l). Of the heavy metals analysed lead, chromium, and nickel concentrations were found to be above the WHO permissible limit, while concentrations of copper and zinc were below the WHO (1983), permissible limit. Manganese concentration was found to fall within WHO permissible limit in 70% of the total samples, while 17%of the samples have concentrations above the WHO standard and four of the samples have concentration below the WHO recommendation.***

***Key word: Physico-chemical characteristics, Sachet water, Kano Metropolis***

## INTRODUCTION

In nature, all water contain impurities, as water flows in streams, accumulate in lakes and filters through layers of soil and rock in the ground, it dissolves or absorbs substances it come in contact with, which may be harmful or harmless (Ogamba, 2004).

Purified raw water to remove physical, chemical, and microbial contaminants, package into suitable containers with labelle is known as package water, the quality of package water is said to be governed by its eventual use (Mendie, 2005). Package water is classified into three on the basis of method of purification and mode of usage viz; industrial water, compendial water and drinking or table water.

One of the major and critical problems in most developing countries today is the provision of an adequate and safe drinking water to its populace (Kulshershtha, 1998). Drinking water that is safe and aesthetically acceptable is a matter of high priority to National Agency for Foods and Drugs administration and control (NAFDAC) and other regulatory agencies. Drinking water that is fit for human consumption is expected to meet the WHO standards and be free from physical and chemical substances and microorganisms in an amount that can be hazardous to health (Denloye, 2004). It is a known fact that no single method of purification can eliminate 100% contaminants from drinking water. However, water can be and should be made safe for consumption within acceptable limits (Denloye, 2004).

Packaged water is any water produce based on the principle of current Good Manufacturing and Automated Practice (cGMAP), distributed or offered for sale sealed in food grade containers or other materials and intended for human consumption. The production of sachet water started in late $20^{th}$ century, it started locally with no purification or with the water only boiled and allowed to settle for sometimes. However, the production of sachet water today has improved and more scientific in all parts of the country (Denloye, 2004).

The quality of water can be evaluated using senses of sight, smell and taste (organoleptic attributes) to identify the appearance, colour, odour, taste and sensation to determine the aesthetic valve (e.g pleasantness, unpleasantness, palatability and acceptability). The physical characteristics of drinking water by themselves could sometimes be indicators of the chemical and microbiological quality of the water (Denloye, 2004).

Pure water is colourless, odourless and tasteless with high boiling and melting points as well as high heat of vapourization. Pure water slightly ionized reversibly to yield hydrogen and hydroxyl ions. Therefore, water is not just a solvent in which the chemical reactions of the living cell occur (Talwar, *et al.,* 1989). It is very often in direct participation in those reactions (Nelson and Cox, 2005). In addition, quality of drinking water is evaluated on the basis of its chemical components. This is done by assessing the pH, hardness, total alkalinity, dissolved oxygen, carbondioxide, heavy metal and other organic/inorganic constituents (Denloye, 2004).

Consumption of sachet water in Nigeria is on the increase irrespective of whether they have NAFDAC Certification or not. However, despite the strong effort by NAFDAC in the regulation and quality assessment of sachet water, there are a growing number of reported public illnesses after drinking sachet water. There are a number of reported cases of typhoid, diarrhea and other water borne diseases arising from consumption of sachet water (Ogamba, 2004).

## MATERIALS AND METHODS

**Study area** The study was conducted in Kano metropolis and Kano State is located on longitude 9°30'N and 12°30'Nand latitude 8°42'E and 9°30'E in the Sudan Savannah zone of Nigeria. The state is characterized by two seasons, rainy which last May to September and dry season that last from October to April. The mean annual temperature ranges between 16-47°C and the mean annual rainfall ranges from 700-1160 mm (Olofin, 1980).

**Sample Collection:**

A total of 30 sachet water samples were purchased from various manufacturers in all the six local government areas that make up Kano Metropolis, five samples from each of local government namely Nassarawa, Municipal, Tarauni, Dala, Gwale and Fagge. The samples were collected during the hot season (March - April) when sachet water production is at its peak and immediately transferred to the Biochemistry Laboratory of Bayero University, Kano where they were stored at room temperature until needed.

**Physico – chemical analysis**

The samples were analysed for pH (using pH metre MPA CD 720), taste, colour and odour (using senses of sight, taste and smell). Alkalinity and Hardness as describe by Aluko *et al.,* (2000). Determination of chloride was carried out by the method described by Morl (as reported by Aluko, *et al.,* 2000). The metals; zinc, copper, cobalt, nickel, manganese, lead, chromium were determined using atomic absorption spectrophotometer (AAS), while sodium, potassium and calcium were determined using flame photometry. Quality assurance was achieved by duplicating each analytical determination.

**Statistical analysis**

The result were statistically analysed using t – test operated through SPSS software developed by Microsoft Inc. to calculate the level of significance ($p < 0.05$) between mean values of the variables assessed in different sample purchased from the study sites.

## RESULTS AND DISCUSSION

Table 1 summarizes the results for pH, temperature, odour, and turbidity determination in sachet water samples purchased from the six local government areas of Kano state (i.e., Nassarawa, Municipal, Tarauni, Dala, Gwale and Fagge which are represented by the letter A, B, C, D, E and F respectively). The mean pH value ranges 4.68 – 8.81, of which 20% were acidic hence 80% are within the standard set by WHO (6.5 – 8.5) for drinking water. The odour is unobjectionable, thereby all samples analysed are odurless which is the characteristics of drinking water. Turbidity which measure cloudiness is within the acceptable value of WHO.

**Table 1: physical quality of some sachet water around Kano metropolis**

| **Sample Site (code)** | **pH** | Temperature (°C) | Odour | turbidity NTU | taste | colour |
|---|---|---|---|---|---|---|
| A | 7.99 ± 0.089 ab | 29 | *Unobj. | < 1 | tasteless | colourless |
| B | 7.16 ± 0.089 | 30 | Unobj. | < 1 | tasteless | colourless |
| C | 6.47± _0.979a | 30 | Unobj. | < 1 | tasteless | colourless |
| D | 6.43± 1.50 | 30 | Unobj. | < 1 | tasteless | colourless |
| E | 6.54± _1.73 | 30 | Unobj. | < 1 | tasteless | colourless |
| F | 7.09 ± 0.140 b | 30 | Unobj. | < 1 | tasteless | colourless |

Different sample bearing similar alphabet(s) are significant at $p<0.05$

*Unobjectionable

Table 2 summarizes the levels of alkalinity, total hardness, mineral element and heavy metals of sachet water samples obtained from the aforementioned areas. Alkalinity which is due to activities of bicarbonates, carbonates and hydroxide of the entire sample analyzed ranges between 3.33 – 31.67 ppm and most the sample show alkalinity below the WHO limit. While total hardness ranges between 27.68 – 41.28 ppm falls below the WHO limit. There was no significant difference in both alkalinity and total hardness between the samples at $p< 0.05$. Chlorides value of the analysed samples ranged 109 – 202 ppm, most samples has chloride values above WHO limit. Levels of the mineral elements sodium, potassium and calcium in the samples studied are within acceptable limits. Values for the heavy metals; zinc, copper, cobalt and manganese in analysed sample are within WHO permissible limit, while values for lead, chromium and nickel were above the WHO allowable concentrations.

## DISCUSSION

This research work analysed physico-chemical properties of some sachet water purchased from the study areas even though their consumption is not limited to these areas. Twenty one of the samples (70%) were NAFDAC approved while nine (30%) were not.

The assessment of organoleptic attributes (colour, taste and odour) showed all the samples to be clear with no taste or smell. This determines the aesthetic value (i.e. pleasantness, palatability and acceptability of the water) (Denloye, 2004). This is expected as many of the industries get their water supply from municipal water plant or bore holes and pass it through industrial and micro-filters.

The mean pH values of most samples were found to fall between 6.43 – 7.99, which agrees with the report of Mendie (2005) which indicated that the large majority of public water supplies may register a pH range between 6.9 – 7.4. This shows that almost all the samples fell within the WHO acceptable limit (6.5 – 8.5). pH is one important quality parameter which indicates the aesthetic quality of water such as taste and has no serious health significance (Ogamba, 2004). The few samples with acidic pH value could be due to treatment processes by the addition of chemicals.

The results show that most of the samples have alkalinity below the WHO permissible limit, which ranged between 3.33 – 31.67 ppm. Alkalinity is a function of bicarbonates, carbonates and hydroxide, this may be possibly due to the fact that most of the water industries use hydrated lime, reverse osmosis and even resin in an attempt to reduce water hardness, thereby removing significant amount of calcium as calcium carbonate. It has been indicated that treated water alkalinity is mainly influenced by the chemical treatment for coagulation, water softening and corrosion control (APHA, 1985).

The alkalinity of the groups A, B, C, D, F showed no significant difference at $P > 0.05$ with the highest alkalinity from site A and the lowest from site C. Alkalinity is another very important parameter. It is the acid neutralizing capacity of water and a function of all titratable bases present in the water (Denloye, 2004). This indicates that most of the sachet water samples studied was distributed with low alkalinity.

Total hardness of water is as a function of carbonate and bicarbonate, when hardness numerically is greater than the sum of carbonate and bicarbonate alkalinity, that amount of hardness equivalent to the total alkalinity is called "carbonate hardness". The amount of hardness in excess of this is called "bicarbonate hardness", Total hardness of the water samples was found to be below the WHO standard limit with mean value ranging between 27.68 – 41.28 ppm. One of the samples was observed to have zero hardness, which is likely due to the use of ion resin or reverse osmosis which completely removes minerals in the water leaving behind hydrogen ions ($H^+$). In confirmation of this observation, the same test was carried out with distilled water and deionized water, which were also found to have the same result. This finding agrees with the fact that the hardness may range from zero to hundreds of milligrams per litre, depending on the source and treatment to which the water has been subjected.

The presently analysed water however, may not suitable for consumption as significant amount of these mineral ions ($Ca^{2+}$, $PO_4^{2-}$ $Mg^{2+}$, $HCO_3^{2-}$ etc ) that are required as supplement for normal body function, are not in adequate amount.

The results show that lead and chromium concentrations were above WHO permissible limit. This may not be unconnected the facts that Kano metropolis is characterized by high population, traffic congestion and industrial activities among others. while concentration of zinc is within the WHO permissible limit. The value of copper, cobalt and manganese varies with some samples falling below the WHO standards while others were above the WHO standards.

The analysis of exchangeable cations (sodium, potassium and calcium) shows that their concentrations fall within acceptable limits. The concentration ranged between 0.0612 – 2.676 ppm, 1.891 – 6.856 ppm, and 0.680 – 5.779 ppm for sodium, potassium and calcium respectively. Potassium and sodium are the major mineral cations of the intracellular and extracellular fluid respectively. They are responsible for the maintenance of the body fluid osmolarity and are also important for nerves and muscle function. Caclium is the major mineral cations of the bones. It is required for impulse transmission, blood clotting, mediation of hormonal signals, muscular contraction and function as cofactor in many enzymes.

**CONCLUSION**

From the results of this preliminary work, no brand of sachet water samples analysed completely meets the WHO guideline for drinking waters. This could be attributed possibly to non involvement of the services of qualified consultant by the producers and ignorance of the functional principles and need of water softeners. High quality packaged water can be produced consistently by following current Good Manufacturing and Automated Practice (cGMAP) and sticking to standard order of production (SOP), which can only be possible with the help of a qualified consultant. Good quality packaged water can also be produced by ensuring that packaging materials are of good grade properly handled, stored and distributed in clean and hygienic condition.

**Table 2: Chemical quality of some sachet water around Kano metropolis**

| Sample Site (code) | Alkalinity (mg/l) | Total hardness (mg/l) | Chloride (ppm) | Lead (ppm) | Zinc (ppm) | Chromium (ppm) | Copper (ppm) | Cobalt (ppm) | Nickel (ppm) | Manganes (ppm) | Sodium (ppm) | Potassium (ppm) | Calcium (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A** | 15.50 ± 8.305 | 27.68 ± 7.56 | 166.85 ± 36.41 | $0.326^{ab}$ ± 0.185 | 0.111 ± 0.049 | 0.468 ± 0.59 | 0.069 ± 0.041 | 0.149 ± 0.072 | $0.165^{a,b,c,d}$ ± 0.100 | $0.058^{a}$ ± 0.291 | $1.30^{a}$ ± 0.291 | 3.688 ± 1.269 | $1.814^{abc}$ ± 0.703 |
| **B** | 7.50 ± 3.68 | 31.60 ± 4.50 | 140.00 ± 4.50 | 0.582 ± 0.153 | 0.123 ± 0.016 | $0.67^{e}$ ± 0.082 | $0.03^{bcd}$ ± 0.019 | 0.189 ± 0.134 | $0.310^{e,g}$ ± 0.134 | $0.063^{b}$ ± 0.024 | 1.32 ± 0.137 | 3.593 ± 0.198 | 2.918 ± 0.980 |
| **C** | 6.50 ± 2.786 | 34.96 ± 17.867 | 134.62 ± 1.831 | 0.766a ± 0.262 | 0.133 ± 0.030 | $0.801^{a}$ ± 0.169 | $0.035^{e,f}$ ± 0.021 | 0.201 ± 0.084 | $0.376^{agh}$ ± 0.072 | $0.092^{c}$ ± 0.036 | 0.994 ± 0.242 | 3.593 ± 0.259 | $3.250^{a,d}$ ± 0.374 |
| **D** | 12.50 ± 11.99 | 38.32 ± 10.37 | 146.97a ± 7.68 | $0.809^{b,d}$ ± 0.296 | 0.133 ± 0.027 | $0.759^{b}$ ± 0.121 | $0.078^{b}$ ± 0.079 | 0.172 ± 0.073 | 0.475b, i ± 0.119 | 0.138 ± 0.073 | 1.392 ± 0.331 | 3.830 ± 0.388 | 2.646d ± 0.272 |
| **E** | 9.66 ± 10.48 | 30.50 ± 6.97 | 133.20 ± 24.19 | 0.795 ± 0.341 | 0.091 ± 0.039 | $0.816^{c,e}$ ± 0.066 | $0.150^{a,c,e,g}$ ± 0.033 | 0.224 ± 0.069 | $0.682^{c,e,g}$ ± 0.118 | 0.106 ± 0.041 | 1.590 ± 0.652 | 4.208 ± 1.545 | $3.326^{b}$ ± 0.450 |
| **F** | 7.67 ± 14.73 | 41.28 ± 14.73 | $123.39^{a}$ ± 5.64 | $1.035^{c,d}$ ± 0.353 | 0.109 ± 0.046 | 0.109 ± 0.094 | $0.082^{d,f,g}$ ± 0.019 | 0.247 ± 0.066 | $0.816^{d,t,h}$ ± 0.182 | $0.172^{a,b,c}$ ± 0.041 | 1.223 ± 0.248 | 3.357 ± 0.388 | $3.235^{c}$ ± 0.687 |

Values are mean + SD, n = 5.
Values on the same column bearing similar superscript (s) are statistically significant

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