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## Original Article

# Heavy Metal contents of sachet Water in Gombe, Nigeria.

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## ABSTRACT

**Background:** The provision of adequate clean drinking water is a basic human need in every society. In Nigeria, like many developing countries, the provision of clean drinking water is not adequate. The introduction of sachet water is seen by many as a solution to the problem. This is because it is affordable where more than a litter of it is sold at ten Naira or even less. The availability and affordability of sachet water have made it a preferred choice for most people despite questions being raised about the purity and potential toxicity. **Objectives:** To evaluate the heavy metal contents of sachet water in Gombe, Nigeria. **Methodology:** Forty samples of sachets water were bought randomly from the streets of Gombe and were analyzed for heavy metals content (lead, cadmium, mercury, arsenic and nickel) using Atomic Absorption Spectrophotometer (AAS). The data obtained were analyzed for frequencies and percentages for qualitative data and minimum and maximum for quantitative data using the system for statistical package for the social sciences (SPSS) version 20.00 for windows. **Results:** None of the sachet water samples had the date of manufacture or expiry date while about 23% had no National agency for food and drug administration and control (NAFDAC) registration numbers. All the samples had lead levels above the WHO safety limits of 0.01mg/L. Mercury, cadmium and arsenic levels were higher than the safety limits in 23%, 15% and 5% of the samples respectively. No nickel was detected in all the samples. **Conclusion:** The majority of the sachet water in Gombe is contaminated with heavy metals lead, mercury and cadmium in concentrations above the WHO safety limits. Processes of water purification should be put in place to reduce the heavy metal contents of sachet water in Gombe.

**Keywords:** *Gombe, heavy metals, sachet water, toxicity*

## Introduction

The provision of adequate clean drinking water is a basic human need in every society.1 It is common knowledge that water may contain impurities including but not limited to heavy metals and biological agents which accumulates by coming into contact with soil as it goes underground from the surface. Because of the various categories of water impurities, there is no single adequate purification method.[2]

In Nigeria, like many developing countries, the provision of clean drinking water is not adequate.[3] Despite various efforts by different governments at different levels and despite their claims as to the improvement in water supply, many communities lack adequate potable water.

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The introduction of sachet water is seen by many as a solution to the problem of inadequate clean drinking water. This is because of the perception by the population as to the affordability of the sachet water where more than a litter of it is sold at ten Naira or even less. Sachet water has become major drinking water for most Nigerians. Studies have shown that about 70% of the Nigerian population consume at least one sachet of water per day.[4] The availability and affordability of sachet water have made it a preferred choice for most people despite questions that had been raised about its purity and potential toxicity.

There have been concerns regarding sachet water including the hygiene of the production process, vendor hygiene, environmental contaminants including chemicals like heavy metals and the environmental degradation caused by the disposed of sachets.[5]

Both biological and chemical contaminants in sachet water have been associated with both acute and chronic diseases such as diarrhoea, decreased gastrointestinal (GI) transit time, kidney diseases and cancers.[6] The biological agents identified in sachet water by some studies include bacteria such as Bacillus species, Streptococcus species, Klebsiella species, pseudomonas as well as Enteric pathogenic protozoans.[7-8] Many studies have also looked at heavy metals contents of sachet water,[10-11] metals include lead, cadmium, copper, nickel etc and were found in quantities above the recommended safety limits in some studies.[10-11] These heavy metals have the potential of accumulating in human tissues over a long time leading to chronic toxicities. Toxicities from these heavy metals are associated with chronic illnesses affecting various organ systems some of which occur through oxidative stress.[11-13]

It is also common knowledge that most of the sachet water vendors keep the product under the sun in the markets and streets. However, little work has been done on the area of the effect of temperature on the chemical contents of sachet water as the high temperature is capable of dissolving some chemicals from the sachet into the water.

Any health or environmental problem/toxicity associated with sachet water will assume public health importance given the extensive consumption of sachet water by the population and there is a paucity of data in that regard especially in the North-East, Nigeria. Therefore, this study set out to evaluate the heavy metal contents of sachet water in Gombe, Nigeria.

**Aim of the study**

This study set out to evaluate the heavy metal contents of sachet water in Gombe, Nigeria.

**Objectives of the study**

Evaluate the heavy trace metal (lead, cadmium, mercury, arsenic and nickel) contents of sachet water in Gombe, Nigeria.

Compare the concentrations of heavy metals (lead, cadmium, mercury, arsenic and nickel) in sachet water in Gombe with the standard set by the World health organization (WHO).

**Materials and methods**

***Study Area***

This study was conducted in Gombe, the capital city of Gombe State, Nigeria. Gombe metropolis has an estimated population of 319,875 and lies within latitude 10° 17' N and 10° 283' N and longitude 11°10'E and 11° 167'E of the Greenwich Meridian. Gombe is a tropical area with two seasons (rainy – May to October and dry –November to April). The climate is Sudan Savanna with temperatures ranging between 18° to 39° and annual rainfall of about 954mm. The town water supply is mainly from the Dadin Kowa water treatment plant and a few boreholes spread across the town. These sources are grossly inadequate. The study will be conducted in the dry season between January and April 2021.

***Study design***

It is a cross-sectional study where the research assistants went to all the major markets, motor packs and major streets in Gombe metropolis to purchase any available sachet water they came across at the time of the study making sure no brand is bought twice. sachets water was also purchased from sachet water industries along the areas visited by the assistants. Samples of water were assessed for address, date of manufacture, expiry date, batch number, mineral contents and NAFDAC registration number. Each sachet water sample was cut by the edge using a sterile pair of scissors. 50ml of water was collected in a sterile sample bottle. Samples were analyzed for the quantities of lead,

cadmium, mercury, arsenic and nickel using atomic absorption spectrophotometry[14].

## ATOMIC ABSORPTION SPECTROPHOTOMETRY (AAS) PRINCIPLE

Heavy metals were determined with flame atomic absorption spectrophotometer (AAS) using direct methods. The atoms of the element (aspirated into the AAS) vaporized and absorbed light of the same wavelength as that emitted by the element when in the excited state. The amount of light absorbed is directly proportional to the concentration of the trace element.

### *Procedure*

Atomic absorption spectrophotometer measurement of the trace elements concentration in water samples was performed on a Beck 200 (AAS). The frozen plasma samples were thawed and diluted with 0.1N hydrochloric acid; HCl (1:20) to release bound heavy metals to enhance accurate measurement.

The digested samples were aspirated directly into the AAS for analysis. Working standard solutions were prepared by diluting the stock standard with de-ionized water and the required part per million (ppm) was used for the standardization of the corresponding trace elements.[14]

### *Statistical analysis*

The data were analyzed using a statistical package for the social sciences (SPSS) version 20.00 for windows (IBM Corp. Chicago IL 2011). The frequencies and percentages were determined for presence or absence of an address, date of manufacture, expiry date, batch number, chemical contents and NAFDAC registration number. The frequency and percentage of sachet water brands with heavy metal contents greater than the WHO safety limits were calculated. The maximum and minimum levels of lead, cadmium, copper and nickel in the samples was also presented. The data were presented as frequencies and percentages in tables.

## Results

All the forty sachets analyzed had the name, address and contact phone number printed on them. However, none of them has the date of manufacture/expiry date, batch number or mineral contents. NAFDAC registration numbers were present on 31 (77.5%) of them while 9 (22.5%) had no such number. Thirty-eight (95%) carry information about the sachet disposal while 2 (5%) had no such information. Five (12.5%) had no guidance on how to store the sachet water. (Table 1).

**Table 1:** Provision of relevant information on the sachet

| Information | Present | Absent |
|---|---|---|
| **Name** | 40 (100%) | 0 (0%) |
| **Address** | 40 (100%) | 0 (0%) |
| **Date of manufacture** | 0 (0%) | 40 (100%) |
| **Expiry date** | 0 (0%) | 40 (100%) |
| **GSM** | 40 (100%) | 0 (0%) |
| **NAFDAC number** | 31 (77.5%) | 9 (22.5) |
| **Batch number** | 0 (0%) | 40 (100%) |
| **Mineral composition** | 0 (0%) | 40 (100%) |

All the forty samples of sachet water analyzed had lead values above the WHO safety limit (0.01mg/L) with the minimum and maximum of 0.0196mg/L and 0.0622mg/L respectively. Cadmium was found to be higher than the WHO safety limits in 6 (15%) of the samples with the maximum level of 1.56mg/L, while it was not detected in all the 34 (85%) remaining samples. Mercury was not detected in 31 (77%) of the samples while the remaining 23% had values above the WHO safety limits with a maximum value of 2.0722mg/L. Arsenic was detected in only 2 (5%) of the samples with a maximum value of 0.799mg/L. No nickel was detected in all the samples analyzed. (Table 2)

**Table 2:** Concentration of heavy metals in sachet water compared to WHO limit

| METAL | WHO LIMIT (mg/L) | ABOVE WHO LIMIT F (%) | MINIMUM LEVEL | MAXIMUM LEVEL |
|---|---|---|---|---|
| **LEAD** | 0.01 | 40 (100%) | 0.0196 | 0.0622 |
| **CADMIUM** | 0.01 | 6 (15%) | ND | 1.5646 |
| **MERCURY** | 0.006 | 9 (23%) | ND | 2.0722 |
| **ARSENIC** | 0.01 | 2 (5%) | ND | 0.7990 |
| **NICKEL** | 0.02 | 0 (0%) | | |

## Discussion

Sustainable provision of clean drinking water has been achieved in many developed nations, but for many developing countries like Nigeria, provision of clean potable drinking water remain inadequate.3, 15 This study looked at the safety and potential heavy metal toxicity from sachet water in Gombe, North-Eastern Nigeria.

Although all the forty samples of sachet water studied had the manufacturer's name, address and contact phone numbers as recommended by NAFDAC, none of the samples had information regarding the batch number, mineral contents, manufacturing and expiry dates while 22.5% had no NAFDAC registration number on their labels. This is similar to the findings in other studies[2-4] and shows that most manufacturers of sachet water are not complying with the safety standards of NAFDAC and this may put the consumer at risk of taking contaminated water.

The various sources of drinking water in Nigeria include rivers, streams, boreholes, lakes, etc. most of these sources are susceptible to water contamination from pollutants. The inadequate supply of clean water and perceived contamination of other sources have made sachet water to be seen by many as a solution to the problem. This has been aided by the affordability of the sachet water where more than a litter of it is sold at twenty Naira or even less. Sachet water has therefore become the major drinking water for most Nigerians. Studies have shown that about 70% of the Nigerian population consume at least a sachet of water per day.[4] The availability and affordability of sachet water have made it a preferred choice for most people despite questions being raised about the purity and potential toxicity. The public health importance of sachet water consumption is monumental considering the widespread and frequency of its use. Therefore, any potential toxicity related to the use of sachet water will affect many people in Nigeria.

One of the most important potential toxicities includes the heavy metal content of the sachet water. Heavy metals are elements with high atomic numbers and densities of at least five times higher than water and occur naturally in the ground.[16-17] They are not usually biodegradable and have the potential to accumulate in human tissue. Tissues that may be affected include but are not limited to blood, kidney, liver, heart, and spleen, where they cause various disease conditions.[13,18, 23-24]

The findings in this study showed lead levels in all the samples were significantly higher than the WHO safety limits. This is evident by the fact that even the lowest value found was about twice the safety limit and the highest value was more than six times the safety limit. This may put the population at a considerable risk of chronic lead toxicity with all its potential consequences. The findings in this study of mercury, cadmium and arsenic at levels higher than the safety limits in 23%, 15% and 5% is also a significant one. These findings are similar to what was found by other researchers.[10-11, 17, 19-21,27] The maximum values found in this study ranged from about 80times, 157times to more than 300times the safety limit in arsenic, cadmium and mercury respectively. It is, therefore, a great source of public health concern considering the number of people that will be exposed to health hazards associated with these heavy metals' toxicity in sachet water.

The toxic effects of most heavy metals are found to be mediated by oxidative stress either by blocking the biocatalytic antioxidant actions of Copper, Zinc and Cobalt.[22] or by the generation of reactive oxygen

species in exposed individuals.[25-26]

## Conclusion

There are significantly high levels of heavy metals in sachet water consumed in Gombe and more regulations are needed to reduce their concentrations to a safe limit. This, if done will reduce the risk associated with exposure to these heavy metals.

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