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Research article

PHYSICOCHEMICAL ANALYSIS OF THE QUALITY OF SACHET WATER CONSUMED IN KANO METROPOLIS

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Abstract

Physico-chemical analysis of 25 brands of sachet water packaged within kano metropolis was evaluated. The concentrations of Pb, Fe, Zn and Cu were determined using atomic absorption spectrophotometer (AAS). The pH and conductivity values were measured by electrometric method. The total dissolved solids were gravimetrically determined. Titrimetric method was used to assess the total hardness. The organoleptic properties were determined by physical observations. The results of the concentrations of the metals, conductivity value, dissolved solids and hardness were below the WHO/SON permissible limits. However, some of the pH (4.5-8.5) 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. The provision of drinking water that is not only safe but also pleasing in appearance, taste and odor is a matter of high priority.

Key words: Physico-chemical, Sachet water, Kano metropolis, Guideline values, Organoleptic.

INTRODUCTION

Water of adequate purity which is the life blood of our species, is of vital importance in the existence of life [1,2,3]. The human body composes 65% of water. Health experts stress that we should drink two litres of water a day [1,2,4,]. [5] reported that water is man's most precious resource that cannot be compared to anything, even crude oil.

Nevertheless, diverse of the world's population, lacks access to safe drinking water. Of the more than six billion people on earth, more than one billion (one in six) lack accesses to safe drinking water. Furthermore, about 2.5 billion (more than one in three) do not have access to adequate sanitation services [6]. Together, these shortcomings generate water borne diseases that kill more than six million children every year [7]. The problem of paucity of potable drinking water is habitual in developing countries. In Nigeria, for instance, government could scarcely afford the cost of the infrastructural facilities needed to provide potable water for her citizens, a teeming population of more than 140 million people. The problem is further compounded by limited technology, poor maintenance culture, corruption and requisite skills [6].

Sachet water is any commercially treated water, manufactured, packaged and distributed for sale in sealed food grade containers and is intended for human consumption [8]. 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 fasted growing industry in Nigeria. The production of sachet water requires two important raw materials, water source (which is usually borehole or tap water), and the packaging materials. From boreholes or tap, water is pumped into ground surface reservoir tanks of varying capacities. In the reserrvoir tanks, the water is left for 24 hours. It is then pumped into coagulation, flocculation and sedimentation tanks, where coagulating chemicals such as alum is added. The sediment water is pumped through series of sand and industrial filters into disinfection tank, where disinfection chemicals are added. The disinfected water is passed through industrial micro-filters, UV-sterilizer and finally into the automated water sealing machine [8].

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The quality of the water can be evaluated using the WHO, 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 [2]. 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 [9]. 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 [10,11]. Drinking water is a vehicle for disease transmission [12]. Many drinking water contaminants including various chemicals, physical, microbiological and radiological are known to be hazardous to health [2]. There are number of reported cases of typhoid, diarrhea and other water borne diseases arising from consumption of sachet water [13]. Different works have been reported by many researchers on water quality assessment. [14] conducted a research on the determinations of heavy metals in Challawa rivers, [15] investigated the chemical characteristics of drinking water in Bendel state of Nigeria while [16] conducted a research on physicochemical characteristics of well water in Warri town Delta state and [17] also reported the analysis of ground water quality in Kagarko area of Kaduna 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 threat to public health [7]. The present study focuses on the physicochemical analysis of the quality of 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; Nassarawa, Municipal, Tarauni, Dala, Gwale and Fagge. Meteorologically, Kano metropolis is hot in most time of the year which makes sachet water business vary lucrative.

Sample Collection and Analytical Procedure

The sachet water samples used in this study were collected in the labeled 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 studied. One out of every 20 sachets of a particular brand was sampled. A total of 40 sachets were sampled out of 800 sachets each of all the various brands selected. The 40 sachets were neatly transferred into the labeled homogenization plastic container and mixed thoroughly to obtain a homogenous sample representative of the entire sampling, from where aliquot of 5 litres were drawn for analysis. The residue obtained from the evaporation of the five litre representative sample was digested with 0.1M HNO_3 on sand bath and filtered into $25cm^3$ volumetric flask. The digested sachet water samples, the reagent blanks and standard solutions were analyzed using atomic absorption spectrometer, model Bulk scientific UPG 2.10. The metal contents were calculated by using the straight line equation from the calibration curve plotted. 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 were determine using a digital conductivity meter (model Jenway, 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, odor and taste) were analyzed by physical observation, using sensory organs.

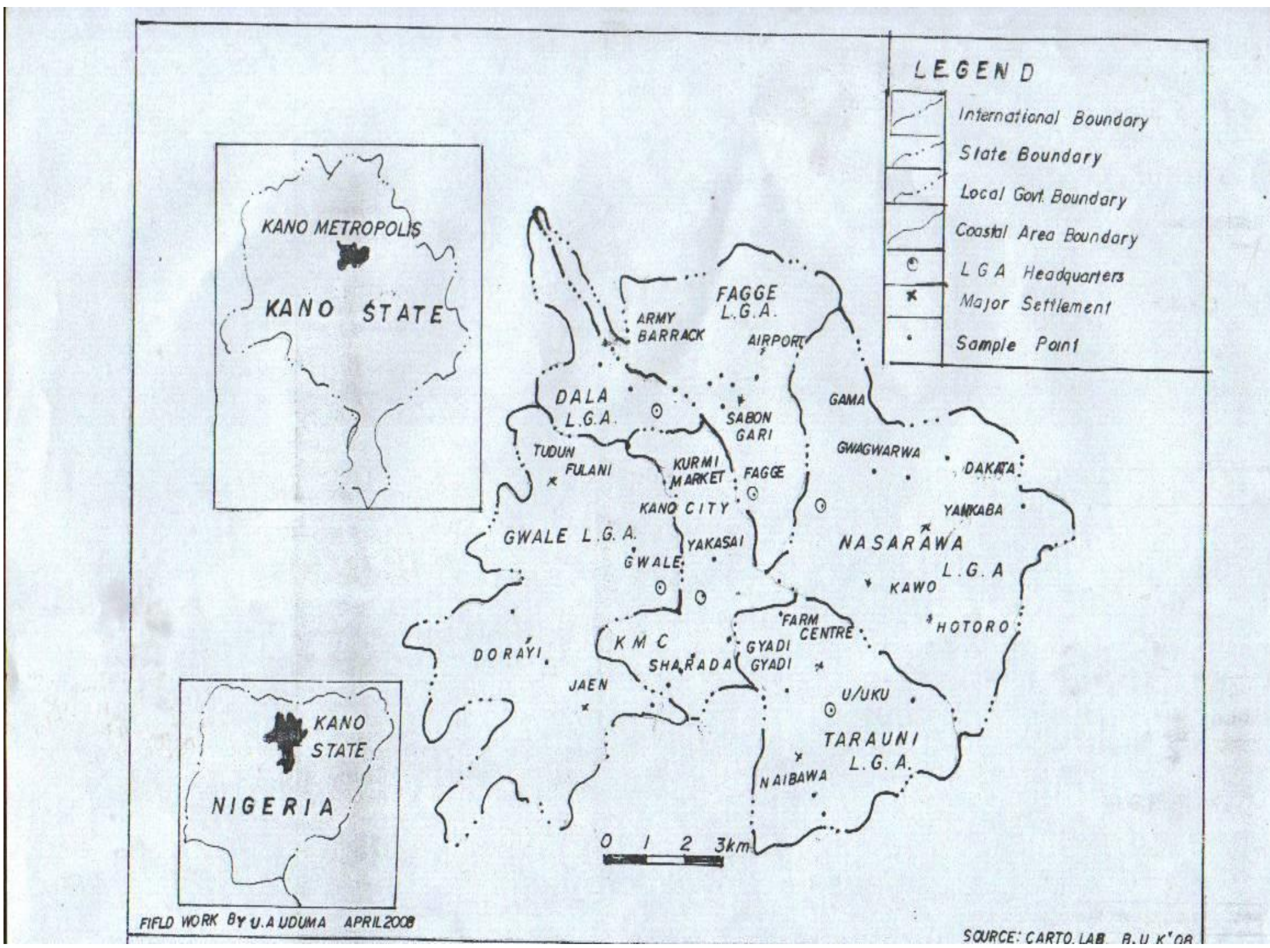

Fig. 1: The Studied Area

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RESULTS

The studied areas are shown in Fig.1. The pH of the sachet water (fig.2.) ranged from 4.2-8.5 indicating acidic, neutral and slightly alkaline. The conductivity of the sachet water (Fig.3) ranged from 45-374(μs/cm). The TDS distribution of the sachet water (Fig.4), skewed towards high frequency of low concentration. The total hardness of the samples determined ranged from 22-351(mg/dm^{-3})(Fig.5). Fig.6 shows that the frequency distribution pattern for the lead is bimodal. Zinc distribution (Fig.7) skewed towards high frequency of low concentration. Fig.8 and Fig.9 indicate that the distribution patterns for the copper and iron skewed toward high frequency of low concentrations.

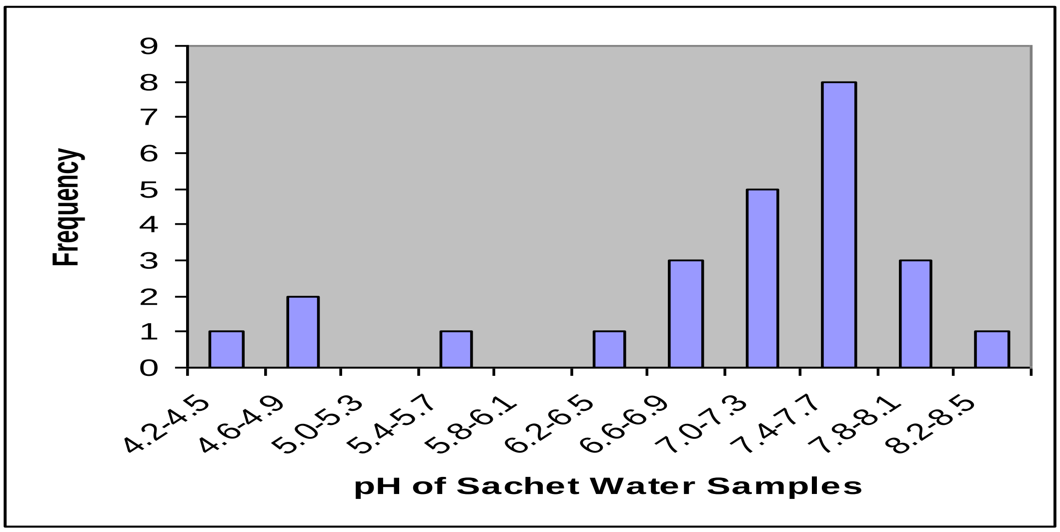

Fig. 2: Frequency Distribution Pattern for pH in Sachet Water Samples

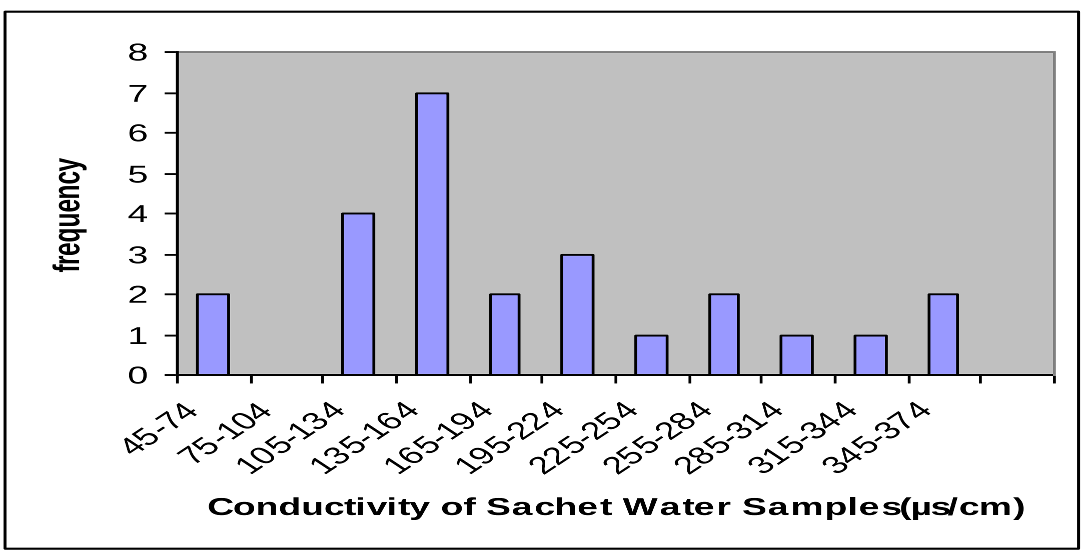

Fig. 3: Frequency Distribution Pattern for Conductivity of Sachet Water Samples

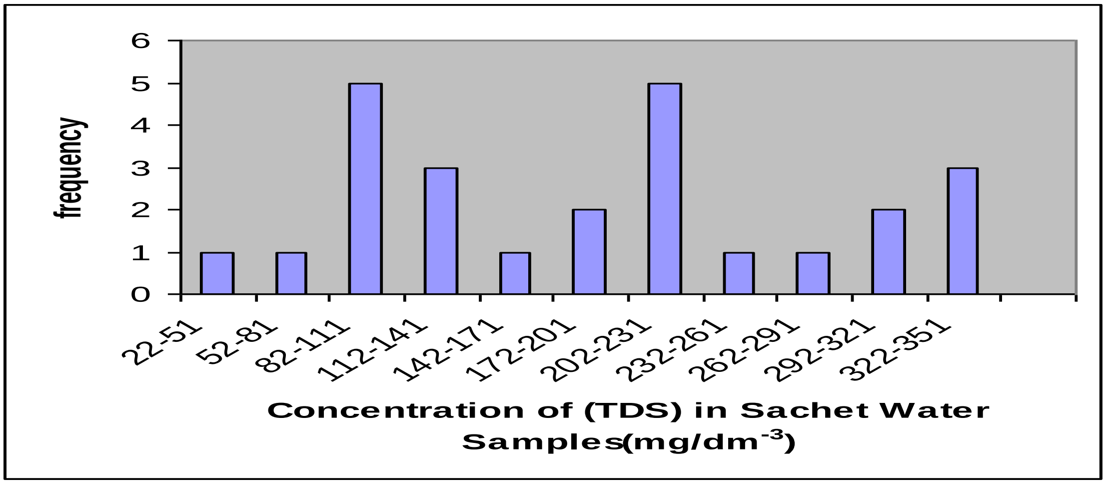

Fig. 4: Frequency Distribution Pattern for Concentration of Total Dissolved Solids in Sachet Water Samples

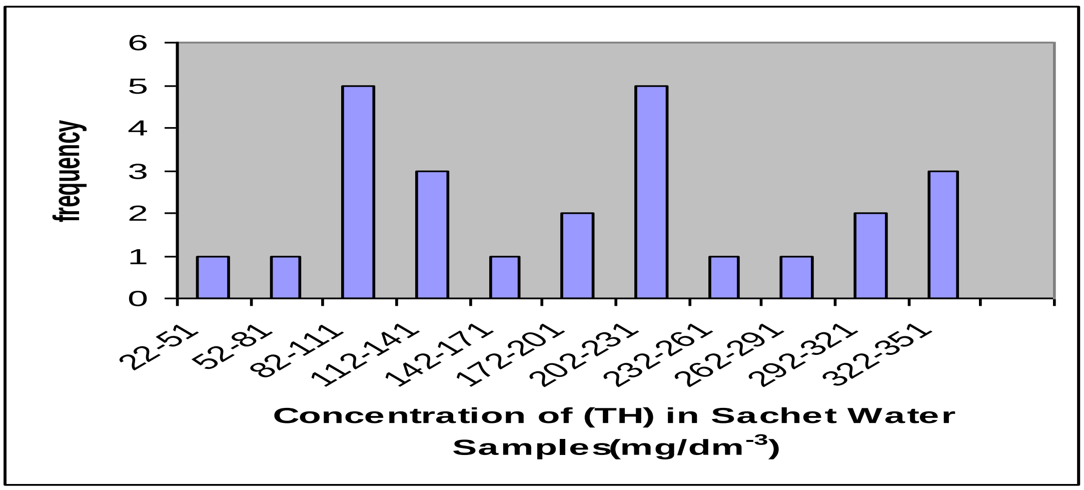

Fig. 5: Frequency Distribution Pattern for Concentration of Total Hardness in Sachet Water Samples

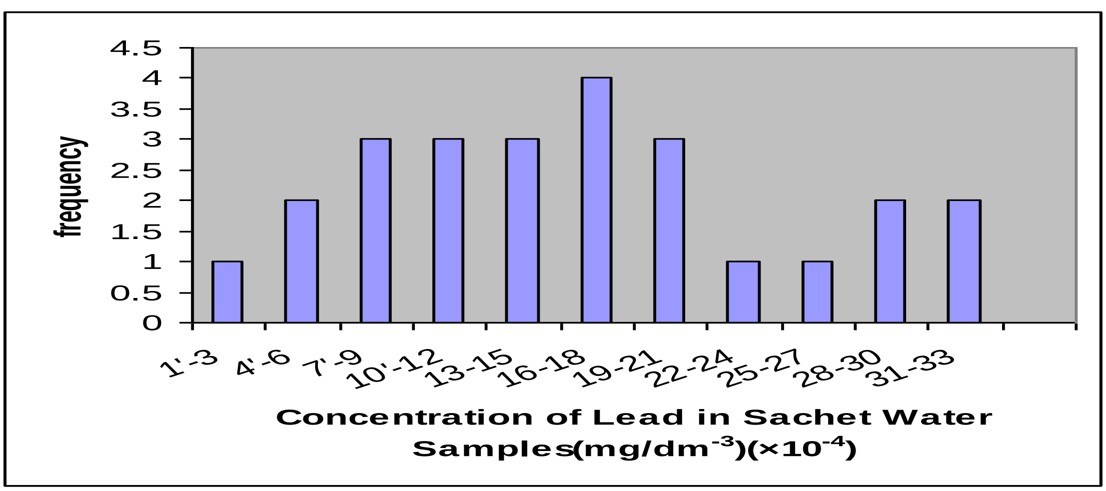

Fig.6: Frequency Distribution Pattern for Concentration of Lead in Sachet Water Samples

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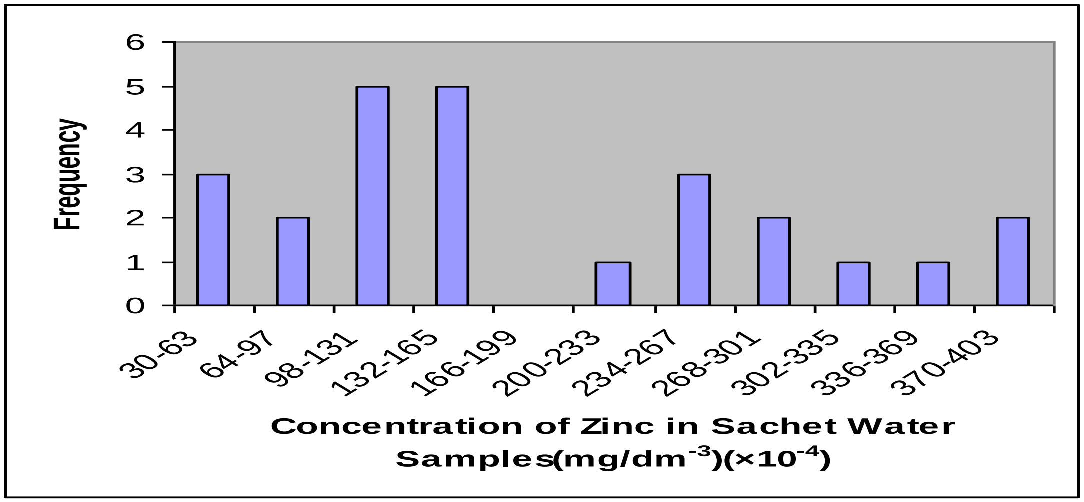

Fig .7: Frequency Distribution Pattern for Concentration of Zinc in Sachet Water Samples

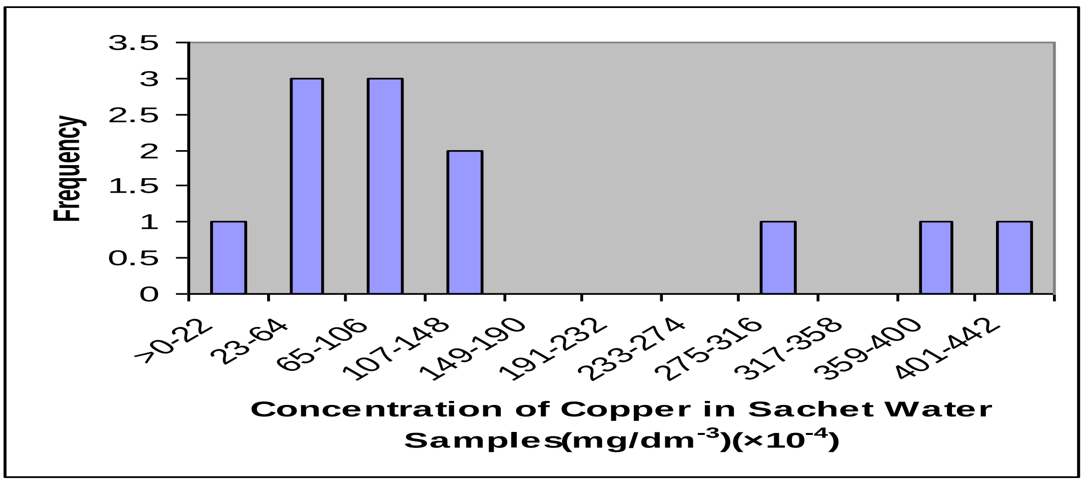

Fig .8: Frequency Distribution Pattern for Concentration of Copper in Sachet Water Samples

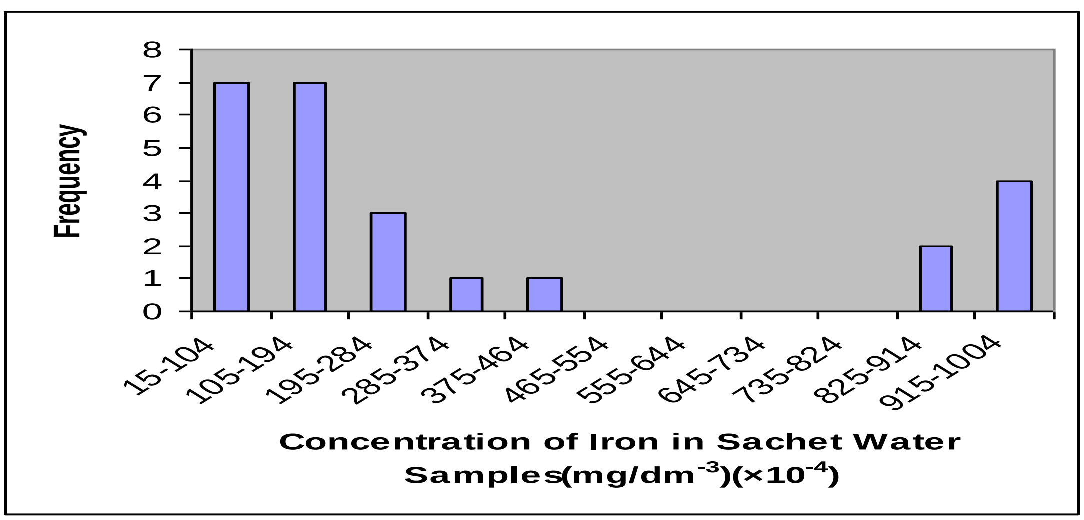

Fig .9: Frequency Distribution Pattern for Concentration of Iron in Sachet Water Samples

DISCUSSION

On the organoleptic assessment, the sampled sachet waters were tasteless, colourless and odorless. This showed that the sachet water samples had good aesthetic value [8]. The pH values obtained showed that twenty of the samples had pH within the WHO, acceptable limits (6.5 to 9.5) while five samples fall below the permissible limits. Low water pH can cause gastro-intestinal irritation in sensitive individuals [18]. The conductivity were found to be between 68 to 375 µs/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 [19]. The concentration of the total dissolved solids (Fig.4), were below the permissible limits of (500-1500mg/dm^3) set by SON and WHO [19]. Low loaded TDS, imparts flat, insipid taste to drinking water [20]. The total hardness levels (Fig.5) were lower than the WHO permissible limits of 100mg/dm^3. Drinking water with hardness less than 75mg/dm^3 may have adverse effects on mineral balance in the body [21]. The lead concentrations (Fig.6) were below WHO maximum limits (0.01-0.05mg/dm^3). The low lead loading was due to the treatments of the water [25]. The concentration of Zn, Fe and Cu (Fig. 7, 8 and 9) in the sachet water were below the WHO threshold limits (2.5mg/dm^3(Zn), 0.03 to 1.0mg/dm^3(Fe) and 1.0-1.5mg/dm^3(Cu)).

CONCLUSION

The concentrations of the metals, 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 essential to sustain life and a satisfactory supply must be available to consumers.

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