INTRODUCTION
The World Health Organization (WHO) recommends 0.5 to 1.5 mg/L as optimum level of fluorides in drinking water supplies to reduce the incidence of tooth decay, dental and skeletal fluorosis in man [1]. Concentrations higher than this can cause multidimensional health problems including mottling of teeth, dental and skeletal fluorosis and several neurological damages in severe cases [2]. Many epidemiological studies of possible adverse effects of the long-term ingestion of fluoride via drinking-water have been carried out. These studies clearly established that fluoride primarily produces effects on skeletal tissues (bones and teeth). Low concentrations provide protection against dental caries, especially in children [1]. The pre- and post-eruptive protective effects of fluoride (involving the incorporation of fluoride into the matrix of the tooth during its formation, the development of shallower tooth grooves, which are consequently less prone to decay, and surface contact with enamel) increase with concentration up to about 1.5 mg of fluoride per liter of drinking-water; the minimum concentration of fluoride in drinking-water required to produce it is approximately 0.5 mg/liter [1].

Li et al. [3] conducted a research in China. In this study, there is an upward trend for the risk of total fractures above an exposure of 1.5 mg fluoride/liter in drinking-water, but only for the highest level of exposure (i.e., >4.32 mg fluoride/liter in drinking-water) was the relative risk statistically significant (RR = 1.47; P = 0.01). In the concentration range of 1.45–2.19 mg fluoride/liter in drinking-water, corresponding to a total intake of 6.54 mg/day, there was a relative risk for all fractures of 1.17 and for hip fractures of 2.13 (both not statistically significant). In summary, estimates based on studies from China indicated that: for a
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total intake of 14 mg/day, there is a clear excess risk of skeletal adverse effects; and there is suggestive evidence of an increased risk of effects on the skeleton at total fluoride intakes above about 6 mg/day. After oral uptake, water-soluble fluorides are rapidly and almost completely absorbed in the gastrointestinal tract. Absorbed fluoride is transported via the blood; with prolonged intake of fluoride from drinking-water, concentrations in the blood are the same as those in drinking-water, a relationship that remains valid up to a concentration in drinking-water of 10 mg/liter. Distribution of fluoride is a rapid process [4]. It is incorporated into teeth and bones; there is virtually no storage in soft tissues.

Incorporation into teeth and skeletal tissues is reversible: after cessation of exposure, mobilization from these tissues takes place. Fluoride is excreted via urine, faces and sweat [4]. Fluoride in inhaled particles is also absorbed, the extent of absorption depending on the size of the particles and the solubility of fluoride compounds present [4]. In a comprehensive carcinogenicity bioassay in which groups of male and female F344/N rats and B6C3F1 mice were administered drinking-water containing up to 79 mg of fluoride per litre as sodium fluoride for a period of 2 years, there was no statistically significant increase in the incidence of any tumour in any single exposed group. There was a statistically significant trend of an increased incidence of osteosarcomas in male rats with increasing exposure to fluoride. However, the incidence was within the range of historical controls [4, 5].

Another 2-year carcinogenicity bioassay involving Sprague-Dawley rats exposed to up to 11.3 mg/kg of body weight per day in the diet also found no statistically significant increase in the incidence of osteosarcoma or other tumours [4]. An additional study, which reported an increased incidence of osteomas in mice receiving up to 11.3 mg/kg of body weight per day, is difficult to interpret because the animals were infected with type C retrovirus [4].

Fluoridated water operates on tooth surfaces: in the mouth it creates low levels of fluoride in saliva, which reduces the rate at which tooth enamel demineralizes and increases the rate at which it remineralizes in the early stages of cavities [6]. Traces of fluorides are present in many waters; higher concentrations are often associated with underground sources, which in turn vary with the type of rock the water flows through [1]. Fluoride's effects depend on the total daily intake of fluoride from all sources. Drinking water is typically the largest source. Consumption of drinking water provides more than 60% of fluoride required by the body. [7]. The aim of this study is to determine the concentration of fluoride in selected sachet water samples that are marketed in Lafia town. Although these works are available, such studies in Lafia, Nasarawa-state have little or no data as to the best of my knowledge.

**Materials and Methods**

**Apparatus and Reagents**

- TISAB (total ionic strength adjusting buffer) Buffer
- Sodium fluoride stock solution
- 5N sodium hydroxide
- Glacial acetic acid
- Ph meter
- Fluoride ion selective electrode (ISE) meter.
- Polyethylene bottles
- Magnetic stirrer and a stirring bar
- Beaker
- Hanna bench top Multi parameter Photometer (HI83200)
- Sample cuvettes (2)
- Caps (2)
- Cuvette cleaning cloth
- Deionized water
- Zirconyl chloride
- Eriochrome cyanine R
- Fluoride reagent (HI93729-0)

**Study Area**

Lafia is a town in the central part of Nigeria and the capital city of Nasarawa state. It has the coordinate’s 8°29'30''N 8°31'0''E as longitude and 8.49167°N 8.51667°E as the latitude, and according to the 2006 census results, it has a population of 330,712 inhabitants [8]. Lafia has a tropical savannah climate with an average annual temperature of 36 °C and is situated on the trunk railway from Port Harcourt and on the main highway between Makurdi and Jos [8].

**Sample Collection, Preparation and Pretreatment**

Ten (10) different brands of sachet table water were collected from various marketers in Lafia town for seven days taking note of the dates of
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production. The water samples collected were Cimthog, Mejoi, Moha, Young star, A.C, Fambel, Diras, Suzab, Tosky and Afrique. They were each transferred into a one (1) litre high density polyethylene (HDPE) bottles and labeled alphabetically (i.e. sample A,B,C,D,E,F,G,H,I,J respectively) according to their brands.

Ion Selective Electrode (ISE) Potentiometric Method

Total Ionic Strength Adjustment Buffer (TISAB)

Fifty seven (57) mL of glacial acetic acid, 58 g of NaCl, 4 g of cyclohexyl aminedinitrilo tetraacetic acid and 500 mL of distilled water were taken in a 1-L beaker. It was cooled in water or ice bath and pH was adjusted from 5.0 to 5.5 by adding 6 M NaOH, then diluted to 1 L with water and stored in a plastic bottle.

Standard Fluoride Solution, 100 Mg/L

NaF was dried at 110 °C for 2 hr. and Cooled in a desiccators. A 0.22 g of the NaF was accurately weighed into a 1-L volumetric flask, dissolved and diluted to the mark with deionized water and stored in a plastic bottle.

Procedure

A 50.00-mL portions of the water was transferred to 100-mL volumetric flasks and diluted to the mark with TISAB solution. A 5 mg/L Fluoride solution was prepared by diluting 25.0 mL of the 100 mg/L standard to 500 mL in a volumetric flask. 5.00, 10.0, 25.0 and 50.0 mL aliquots of the 5 mg/L solution were transferred to 100 mL volumetric flasks, and 50 mL of TISAB solution was added and diluted to the mark. (These solutions correspond to 0.5, 1.0, 2.5 and 5.0 mg/L Fluoride, respectively, in the sample.) After thorough rinsing and drying with tissue paper, the electrode was immersed in the 0.5 mg/L standard and stirred mechanically for 3 min. then the potential was recorded. The procedure was repeated for the remaining standards and samples. Measured potential was plotted against the log of the concentration of the standards. This plot was used to determine the concentration in mg/L of fluoride in the Unknown [9].

Photometric Method

Calibration

The cuvettes was washed with distilled water and rinsed with deionized water. The meter was test-run using a known concentration of fluoride sample content to ensure that the meter is working and reading in a good and required range. Calibration of the apparatus was carried out properly, the cuvette were individually rinsed with the samples to be analysed for proper concentration range and minimizing errors due to contamination of the samples [10].

Procedure

Fluoride method was selected on the Photometer. Two (2) mL of HI 93729-0 SPADNS reagent each was added to two cuvettes. One of the cuvettes was filled with distilled water up to the mark, cuvette cap was replaced and inverted several times to mix. The other cuvette with sample was filled up to the mark; the cap replaced and then inverted several times to mix. The cuvette with the reacted distilled water was placed into the holder and the lid closed. The timer was pressed and the displays showed the countdown prior to zeroing the blank or, alternatively, waited for two minutes and pressed Zero. The measurement was taken and the result was displayed in mg/L of fluoride. The cuvette with distilled water was removed. The other cuvette with the reacted sample was also inserted into the instrument and the results were displayed in mg/L of fluoride. The same procedure was carried out for the rest of the samples analyzed and not less than two times for each sample (ie in duplicate) [10].

Figure 1. Mean Values of Fluoride Concentrations of Ion Selective Electrode (ISE) Potentiometric Method
RESULTS AND DISCUSSION

Fluoride Content Using ISE Method

The mean fluoride concentrations for the various samples were 0.100 mg/L for sample A, 0.203 mg/L for sample B, 0.310 mg/L for sample C, 0.418 mg/L for sample D, 0.205 mg/L for sample E, 0.503 mg/L for sample F, 0.308 mg/L for sample G, 0.308 mg/L for sample H, 0.423 mg/L for sample I and 0.561 mg/L for sample J. These were all within the Bureau of Indian Standard and WHO maximum permissible limit as presented in Figure 1.

The mean concentration of fluoride contained in the various selected sachet table water samples were in the following order: Sample A (0.100) < sample B (0.203 mg/L) < sample E (0.205 mg/L) < sample G and sample H (which had same values of 0.308 mg/L) < sample C (0.310 mg/L) < sample D (0.418 mg/L) < sample I (0.423 mg/L) < sample F (0.503 mg/L) < sample J (0.561).

The concentrations of fluoride for all the ten samples analyzed were similar to that reported in an analysis carried out in Kamassies and Lelie-Fontein [11]. The mean of fluoride according to Moola ranges from 0.05 to 2.0 mg/L: with specifications of ranges 0.00 to 0.5 mg/L as the lower limit and 0.6 to 2.0 mg/L as the upper limit and the most recommended for human health with remark as the higher values (say from 1.0 to 2.0 mg/L) were from borehole water supplies [11].

Fluoride Content Using Photometric Method

The results obtained as presented in Figure 2 showed the variations of fluoride concentrations for the various selected sachet water samples to be within the mean range of 0.430 mg/L of sample E to 0.925 mg/L of sample D and sample G.

The mean concentrations for the individual samples of sachet water analysed as presented in Figure 2 were : 0.516 mg/L for sample A, 0.710 mg/L for sample B, 0.758 mg/L for sample C, 0.925 mg/L for sample D, 0.430 mg/L for sample E, 0.530 mg/L for sample F, 0.925 mg/L for sample G, 0.675 for sample H, 0.875 for sample I and 0.680 mg/L for sample J. These were all within the Bureau of Indian Standard and WHO maximum permissible limit as presented in Figure 2.

From the mean concentration, the fluoride concentration of all the samples ranged from 0.430 mg/L (from sample E) as the lower limit to 0.925 mg/L (from sample D and sample G) as the upper limit. The concentration in descending order can be represented as : 0.925 mg/L (for sample D and G) > 0.875 mg/L (for sample I) > 0.758 mg/L (for sample C) > 0.710 mg/L (for sample B) > 0.680 mg/L (for sample J) > 0.675 mg/L (for sample H) > 0.530 mg/L (for sample F) > 0.516 mg/L (for sample A) > 0.430 mg/L (for sample E).

The results obtained from photometric method of analysis of this study were similar to a research work reported by Abuzied and Elffatow [12], with fluoride content of the samples analysed by the photometric which had the values ranging from 0.05 mg/L (lower limit) to 1.5 mg/L (upper limit) of fluoride concentration.

Comparision of the Results from the ISE Method and the Photometric Method

From the two analytical methods carried out, the fluoride concentration of each of the sachet table water samples were within the permissible limit of 0.00 mg/L to 1.50 mg/L as approved by World Health Organizations [1], and 0.00 to 1.00 mg/L approved by Bureau of Indian Standard [13].

The mean concentrations of fluoride for ISE Method for all the samples ranged from 0.100 mg/L (sample A) to 0.561 mg/L (sample J), and that of photometric method ranged from 0.430
mg/L (sample E) to 0.925 mg/L (sample D and G). The photometric method had higher values than the ISE potentiometric method and can probably be considered as the more sensitive method compared to the ISE method which is the most commonly used method of fluoride determination.

The results obtained from both methods were observed to be lower than the approved level by World Health Organization of 1.5 mg/L and also lower than the approved desired level in Bureau of India Standard of 1.0 mg/L of drinking water [1, 13].

CONCLUSION

This study showed that fluoride was present in the 10 different brands of sachet water samples marketed in lafia town but in different concentrations. The fluoride content were within the WHO save limit of 0.5 and 1.5 mg/L, and Indian save (desirable) limit of 0.00 and 1.00.

REFERENCES


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