

Determination of Fluoride Content of Selected Sachet Table Water Sold In Lafia Nasarawa State-Nigeria Using Potentiometric and Photometric Methods

A.U. Augustine^{1*}, I.S. Ioryue², D. A. Simon¹

¹Department of Chemistry, Federal University Lafia-Nigeria

²Department of Chemistry, Federal University of Agriculture, Makurdi, -Nigeria

*Corresponding Author: A.U. Augustine, Department of Chemistry, Federal University Lafia-Nigeria, Email: abelloves@yahoo.com

ABSTRACT

The concentrations of fluoride was determined in various sachet table water samples by using ion selective electrode method and photometric method. It was observed that the water samples contained fluoride concentrations which were within the consumable range that can cause little or no harm to life. In this study, ten (10) brands (which were cimthog table water, mejoi, moha, youngstar, A.C table water, Fambel water, Diras, Suzab water, Tosky table water, Afrique table water, with the sample identity represented as (Sample A,B,C,D,E,F,G,H,I and J respectively) of different sachet water samples which are marketed in Lafia town were analysed. The fluoride concentrations were found to be within the range of 0.00 mg/L to 1.5 mg/L which were confirmed to fall within the approved lower and upper limit of fluoride concentration by the WHO (2004) and within the desirable limit of Bureau of Indian Standard for drinking water (2010). The mean concentration of fluoride contained in the water samples (i.e samples A,B,C,D,E,F,G,H,I and J) using the ISE Methods was within the range of 0.100 mg/L (of sample A) to 0.561 mg/L (of sample J), while that of Photometric Method was within the range of 0.430 mg/L (of sample E) to 0.925 mg/L of samples D and G). Despite being within the maximum permissible limits of WHO and Bureau of Indian Standard, there is need, however for regular investigation in these brands and other brands to ensure that they are always within the save limits. The ion selective electrode method is the most commonly used but in this study the photometric method using bench top Multi parameter Photometer was more sensitive of the two methods.

Keywords: Concentrations, determination, fluoride, sachet table water, Lafia.

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

Determination of Fluoride Content of Selected Sachet Table Water Sold In Lafia Nasarawa State-Nigeria Using Potentiometric and Photometric Methods

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 sweats [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

Determination of Fluoride Content of Selected Sachet Table Water Sold In Lafia Nasarawa State-Nigeria Using Potentiometric and Photometric Methods

production. The water samples collected were Cimthog, Mejai, 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 cyclohexy laminedinitrilo 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].

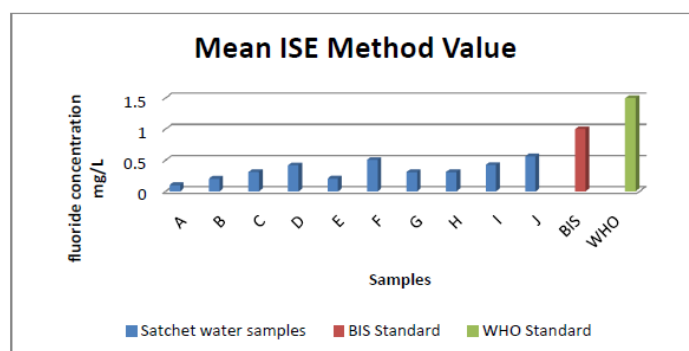


Figure 1. Mean Values of Fluoride Concentrations of Ion Selective Electrode (ISE) Potentiometric Method

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 for sample H, 0.423 mg/L for sample I and 0.561 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].

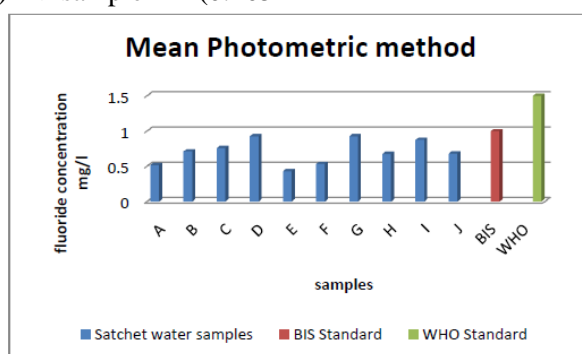


Figure2. Mean Values of Fluoride Concentrations of Photometric Method

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 H.

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.

Comparism 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

Determination of Fluoride Content of Selected Sachet Table Water Sold In Lafia Nasarawa State-Nigeria Using Potentiometric and Photometric Methods

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.

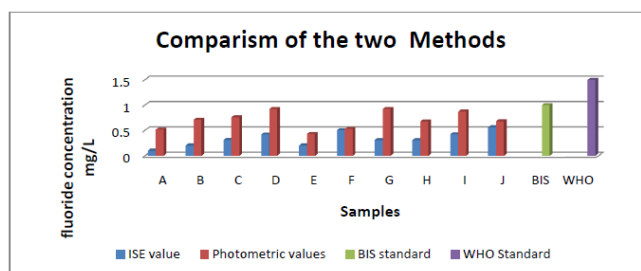


Figure 3. Fluoride Concentrations of the two Methods

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 satchet 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

- [1] WHO (World Health Organisation): Expert Committee on Oral Health Status and Fluoride Use. Fluorides and oral health. 2004.
- [2] Selwitz R.H, Ismail A.I, Pitts N.B: Dental caries. *Lancet*, 369(9555):51–9. doi:10.1016/S0140-6736(07)60031-2 .2007.
- [3] Li Y et al. Effect of long-term exposure to fluoride in drinking water on risks of bone fractures. *Journal of Bone and Mineral Research*, 2001, 16(5):932–939.
- [4] IPCS (International Programme on Chemical Safety): Fluorides. Geneva, World Health Organization, (Environmental Health Criteria 227), 2002.
- [5] NTP(National Toxicology Program) Toxicology and carcinogenesis studies of sodium fluoride (CAS no. 7681-49-4) in F344/N rats and B6C3F1 mice. Research Triangle Park, NC, National Institutes of Health, National Toxicology Program (NIH Publication No. 90-2848; NTP Technical Report 393) 1990.
- [6] Pizzo, G., Piscopo, M.R., Pizzo, I., Giuliana, G.: Community water fluoridation and caries prevention: a critical review. *Clin Oral Investig.* 2007, 11(3):189–193.
- [7] Fawell, J., Bailey, K., Chilton, J., Dahi, E., Fewtrell, L., Magara, Y.: Fluoridation in Drinking water :World Health Organization; Environmental occurrence, geochemistry and exposure. 2006,(7): 5–27.
- [8] Encyclopedia Britannica, Lafia, 2006. Retrieved from :[www.britannica.com/ place/Lafia](http://www.britannica.com/place/Lafia) on August 19, 2018.
- [9] Potentiometric determination of fluoride Retrieved from http://academic.cengage.com/resource_uploads/downloads/0030355230-17077.Pdf (Retrieved on 25th February 2010).
- [10] Jian M. S., Kar M. L.: Feasibility study on fluoride removal in drinking water in Mehsana, India: *International NGO Journal*. 2011, 6(10),:224-228.
- [11] Moola, M.H. :Fluoridation in South Africa. *Community Dental Health* 13. 1996, (suppl 2): 51-55.
- [12] AbuZeid K, ElHatow L: Impact of fluoride content in drinking water,2008. Retrieved September 2, 2011,from<http://water.cedare.int/cedare.int/Main.aspx?code=683>.
- [13] BIS (Bureau of Indian Standard), Indian Standard for Drinking Water-Tolerance and Classification. ISI-ISI: 2296-1982. Manak Bhavan, 9 Bahadur Sha Zafar Marg, New Delhi 110002. 2010.

Citation: A.U. Augustine, I.S. Ioryue, D. A. Simon, "Determination of Fluoride Content of Selected Sachet Table Water Sold In Lafia Nasarawa State-Nigeria Using Potentiometric and Photometric Methods". *Open Access Journal of Chemistry*, 3(2), 2019, pp.15-19

Copyright: © 2019 A.U. Augustine. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.