Available Online at http://www.journalajst.com

ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN: 0976-3376

Asian Journal of Science and Technology
Vol. 5, Issue 2, pp. 124-128, February, 2014

RESEARCH ARTICLE

DETERMINATION OF FLUORIDE AND SOME EFFECTS ON THE DRINKING WATERS OF SOME WARDS IN KALTUNGO LOCAL GOVERNMENT AREAS OF GOMBE STATE NIGERIA

***Danbature, Wilson Lamayi; Fai, Frederick Yirankinyuki and Ayim, Patrick**

Chemistry Department, Gombe State University Gombe, Nigeria

ARTICLE INFO

Article History:
Received 17th November, 2013
Received in revised form
22nd December, 2013
Accepted 10th January, 2014
Published online 21st February, 2014

Key words:
Dental caries
Dental fluorosis
Fluoride
Spectrophotometry

ABSTRACT

Water is essential to life. The assessment of water quality is very important as it is often contaminated. Fluoride being one of the chemical contaminants of water causes dental fluorosis, diminishes bone strength, and causes osteosarcoma and low IQ etc. In this research, a total of 30 samples (six from each location) were collected from Kaleh-Aya, Okra, Poshereng, Popandi and Gombe (as control). The samples were analyzed for fluoride using HACH DR/2000 model spectrophotometer. The results from these ranged from 0.60±0.01 to 1.53±0.01mg/l with the exception of the control. A follow up survey on 60 families was carried out using questionnaire for mottled teeth and fracture from accident in these areas of Kaltungo Local Government Areas. The percentage of mottled teeth ranged from 30.96 to 63.20% while percentage of accident with fracture ranged from 26.09 to 68.00%. It could be concluded there that the high fluoride concentration is responsible for the dental fluoride and diminished bone strength in these areas.

INTRODUCTION

Water is one of the basic necessities of life. Both plants and animals require water to survive. For instance, the blood of humans is made up of 75% water. But this water contains contaminants which vary in quantity and type of water source. The contaminants are both natural and from man's activities which could be biological or chemical. The World Health Organization (WHO; 2006) recommends that good drinking water should be free from contaminants. Mostly in developing countries 80% of the people without access to good drinking water live in rural areas (Water Forum; 2003). In most metropolitan cities in Nigeria, pipe borne water is inadequate both in quantity and quality and poverty appears to underlie the provision and use of safe drinking water. Fluoride is one of the chemical contaminants of water, though in early times, it was believed to be an essential element for animals as well as humans. The World Health Organization through extensive studies has identified dental cavities as a worldwide epidemic. In her effort to prevent this menace she recommended that fluoride should be added to drinking water where naturally occurring levels of fluoride are below optimal levels. Water fluoridation in low fluoride containing water supplies (Brunnel and Carlos; 1990) helps to maintain optimal dental tissue development and dental enamel resistance against caries attack for life. Recently the consumption of naturally fluoridated water or artificially fluoridated drinking water has generated both strong support and opposition within communities and regulatory bodies worldwide. The issue is controversial because fluoride has been known to have beneficial effects at low concentrations. However, at higher concentrations, it is found to have toxic effects. This has prompted so many researchers to study the potential adverse health effect associated with exposure to minimal and higher levels of fluoride. One of the long term effects of prolonged ingestion of fluoride in drinking water is dental fluorosis; which is the first adverse effect of fluoride in drinking water (Wikipedia; 2009).

A literature search revealed only one study into the occurrence of dental fluorosis in Nigeria [Wongdem *et al*., 2001). A total of 475 people aged 5 and over, who were either born in Langtang town or had lived there for a minimum of 5 years, were examined. Enamel status was assessed for mottling using a modified version of Dean's classification. There was a 26.1 per cent prevalence rate of enamel fluorosis in the Langtang town area, with 20.6 per cent of the cases classified as mild and 5.5 per cent as severe. The highest prevalence was seen among 10 to 19 year olds. A follow-up study to determine the fluoride concentrations in Langtang town, found that levels ranged between 0.5 and 3.96 mg l–1 with the highest levels being found in stream sources (Wongdem *et al*., 2001). According to Jenny *et al*. (2009), fluoride can diminish bone strength and increase the risk for bone fracture. However they could not determine the appropriate levels of fluoride that is safe for bones. They noted that, the only useful information suggested was that fracture risk may be worsen at low levels

****Corresponding author: Danbature, Wilson Lamayi***
Chemistry Department, Gombe State University Gombe, Nigeria

as 1.5ppm; which is slightly greater than the concentration (0.7-1.2pm) added for water fluoridation. Several epidemiological studies are available on the possible association between fluoride in drinking water and cancer rates among population. Fluoride is a mutagen; it can cause the uncontrolled spread of certain types of cells including cancer (Wikipedia; 2009). Consumption of fluoride at levels beyond those in fluoridated water for a long time can cause osteosarcoma (Li; 2001). Epidemiological studies have noted a correlation between increase in fluoride level and low IQ (NRC; 2006). It was also reported that at a concentration of 1ppm it has adverse effect on the brain and kidney (ADA; 2005). These effects caused by fluoride contamination of drinking water necessitated this work since people in the selected areas have degraded teeth suspected to be either caries or fluorosis. Therefore there is the need to carry out this work as an effort to find out the cause of the deformity that has denied young men and women the freedom to laugh freely.

MATERIALS AND METHODS

In this work, the spectrophotometric method of water analysis and the survey type of research through the use of questionnaire for the collection of data was used. The model used for this analysis was HACHDR/2000 spectrophotometer adopted from standards for the examination of drinking water and waste water, whose procedures is equivalent to the US Environment Protection Agency (U.S EPA) method (340.1) for drinking water and waste water analysis.

SAMPLING TECHNIQUES

Sampling Techniques for Well Waters

A clean dried sample bottle was tied with a rope, and a washed stone was used as a weight, and then the bottle was tied just above the weight. The cap was uncovered from the bottle and gradually lowered into the well to about some meters. Shortly, when there was no more air bubbles seen and the bottle filled, it was drawn out of the well and the cap immediately covered. Finally, the filled sample bottles were then labeled for easy identification.

Sampling Technique for Borehole Waters

Borehole water valve was opened, the water was allowed to flow to the ground for some time, and then a clean sample bottle was uncovered and placed directly to the pipe for sample collection. When the bottle was filled with water, the cap was immediately covered. The sample bottles were tagged for easy identification as follows;

- KAB_1– Water sample from Kaleh-Aya Borehole
- KAW_1 –Water sample from Kaleh-Aya Well
- CB_1 - Control Borehole Water sample
- CW_1 - Control Well water sample
- PPB_1 – Water Sample from Popandi Borehole
- PPW_1 – Water Sample from Popandi Well
- POB_1 – Water Sample from Poshereng Borehole
- POW_1 – Water Sample from Poshereng Well
- OKB_1 – Water Sample from Okra Borehole
- OKW_1 – Water Sample from Okra Well

REAGENTS

SPADNS (Sodium 2-(Parasulfophenylazo) -1,8-dihydroxy -3,6- naphthalene disulfonate) reagent for fluoride test, and distilled water.

ANALYTICAL PROCEDURE

DETERMINATION OF FLUORIDE (F^-)

PROCEDURE 1: The Spectrophotometer was powered, and then the stored program number (190) for fluoride (F^-) determination was entered through the button at a wavelength of 580nm. 25ml of distilled water was poured into a dry sample cell and 5ml of the SPADNS reagent was added and then mixed together. This solution was used to calibrate the spectrophotometer. After calibration, 25ml of the pretreated sample was mixed with 5mls of SPADNS reagent poured into the same sample-cell and then mixed thoroughly. The solution was allowed to stand for a minute reaction time after which the fluoride concentration was read. The procedure was repeated for all the test samples.

Procedure 2: Questionnaires were designed as a follow up study; for mottled teeth and fracture from accident within the sampled area of Kaltungo (Kaley-Aya, Okra, Poshereng, and Popandi). The questionnaires were distributed at random to sixty families within the sampling areas. Two weeks later, the questionnaires were collected back and treated statistically.

REESULTS AND DISCUSSION

The experimental results obtained from the analysis and the follow up survey for mottled teeth and fracture from accidents are presented in Tables 1 and 2. The results for the survey analysis are as shown in tables 3 to 6.

Table 1. Fluoride Concentration in Borehole Water Samples

S/N	Samples Location	Concentration of F^- (mg/litre)			Average (mg/litre)
		Batch A	Batch B	Batch C	
1	Kaleh-Aya	1.52 ±0.01	1.54±0.01	1.53±0.01	1.53
2	Okra	1.50±0.01	1.51±0.01	1.52±0.01	1.51
3	Poshereng	1.47±0.01	1.46±0.01	1.48±0.01	1.47
4	Popandi	0.89±0.01	0.90±0.01	0.91±0.01	0.90
5	Gombe (As a Control)	0.39±0.01	0.38±0.01	0.37±0.01	0.38

Table 2. Fluoride Concentration in well Water Samples

S/N	Samples Location	Concentration of F^- (mg/litre)			Average (mg/ litre)
		Batch A	Batch B	Batch C	
1	Kaleh-Aya	1.49±0.01	1.51±0.01	1.50±0.01	1.50
2	Okra	1.49±0.01	1.48±0.01	1.50±0.01	1.49
3	Poshereng	1.44±0.01	1.45±0.01	1.46±0.01	1.45
4	Popandi	0.64±0.01	0.62±0.01	0.63±0.01	0.63
5	Gombe (As a Control)	0.19±0.01	0.20±0.01	0.18±0.01	0.19

The experimental results presented in Tables 1 and 2 above show the average fluoride concentrations in the samples from the following communities; Kaleh-Aya, Okra, Poshereng, Popandi ranged as follows 1.50-1.53, 1.49-1.51, 1.45-1.47, and 0.63-0.90 (mg/litre). However, it can be seen from the results

Table 3: Kaleh – Aya

S/N	No. in Family	No. with Complete Stained Teeth	No. with Partially Stained Teeth	No. without Stained Teeth	No. that had Accident	No. that had accident and resulting fracture occurred
1	15	4	6	5	0	0
2	5	0	0	5	0	0
3	9	3	4	2	3	0
4	5	0	3	2	1	0
5	12	7	2	3	0	0
6	10	5	4	1	2	0
7	11	6	3	2	4	1
8	17	10	6	1	4	2
9	7	0	0	7	0	0
10	15	4	2	9	0	0
11	5	1	0	4	1	0
12	8	3	4	1	4	0
13	6	0	2	4	4	3
Total	125	43	36	46	23	6
%		34.4	28.8	36.8		26.09 %

- Percentage with mottled teeth = 63.2 %
- Percentage of Accidents with fracture = 26.09 %

Table 4. Okra

S/N	No. in Family	No. with Complete Stained Teeth	No. with Partially Stained Teeth	No. without Stained Teeth	No. that had Accident	No that had accident And Resulting Fracture occurred
1	6	0	2	4	0	0
2	15	1	0	14	1	1
3	6	0	0	6	1	0
4	11	0	1	10	1	1
5	6	4	1	1	0	0
6	11	0	0	11	0	0
7	9	0	3	6	0	0
8	6	1	1	4	2	1
9	8	1	2	5	2	1
10	3	0	0	3	0	0
11	7	1	1	5	2	2
12	21	10	2	9	2	0
13	4	4	0	0	0	0
Total	113	22	13	78	11	6
%		19.46	11.50	69.02		54.55 %

- Percentage with mottled teeth = 30.96 %
- Percentage of Accidents with fracture = 54.55 %

Table 5. Poshereng

S/N	No. in Family	No. with Complete Stained Teeth	No. with Partially Stained Teeth	No. without Stained Teeth	No. that had Accident	No that had accident and Resulting fracture occurred
1	7	0	0	7	3	1
2	10	7	1	2	1	1
3	10	6	2	2	1	1
4	8	0	1	7	2	0
5	3	1	1	1	2	1
6	5	1	1	3	1	0
7	13	6	2	5	3	1
8	10	2	3	5	4	1
9	13	1	4	8	3	3
10	4	3	0	1	3	2
11	15	0	2	13	3	1
12	8	3	0	5	0	0
13	13	3	1	9	3	1
14	8	0	1	7	1	0
15	7	0	3	4	2	1
16	21	1	0	20	1	1
17	7	3	3	1	1	1
18	9	4	3	2	0	0
Total	171	41	28	102	34	16
%		23.97	16.37	59.64		47.06 %

- Percentage with mottled teeth = 40.34 %
- Percentage of Accidents with fracture = 47.06 %

Table 6: Popandi

S/N	No. in Family	No. with Complete Stained Teeth	No. with Partially Stained Teeth	No. without Stained Teeth	No. that had Accident	No that had accident and resulting fracture occurred
1	7	3	1	3	0	0
2	6	2	1	3	3	2
3	5	3	1	1	2	1
4	14	5	2	7	0	0
5	10	3	1	7	2	1
6	7	0	1	6	1	1
7	9	0	1	8	2	2
8	6	2	2	2	2	1
9	5	1	2	2	0	0
10	8	3	2	3	3	2
11	10	4	2	4	4	3
12	7	2	2	3	2	2
13	5	1	1	2	1	1
14	9	2	4	3	3	1
15	7	0	1	6	0	0
Total	115	31	24	60	25	17
%		26.95	20.86	52.17		68.00 %

- Percentage with mottled teeth = 47.81 %
- Percentage of Accidents with fracture = 68.00 %

that borehole water (Table 1) had fluoride levels that ranged from 0.90 ± -1.53± (mg/litre). And the corresponding Well water (Table 2) had fluoride levels ranged from 0.63 ± - 1.50 ± (mg/litre). It could be deduced therefore, that Borehole water had high fluoride concentrations than well water samples. Consequently, the results obtained from the follow up survey study (Tables 3-6) showed that Kaleh-Aya, had a percentage of 63.20% persons with mottled teeth and 26.09 % cases of fracture resulting from accident. Okra had 39.96 % percent persons with mottled teeth and 54.55 % cases of fracture resulting from accidents. Poshereng, had a percentage of 40.34 % persons with mottled teeth and 47.06 % cases of fracture from accidents. And Popandi had 47.81 % persons with mottled teeth and 68.00 % cases of fracture resulting from accidents.

It could be seen from the results obtained that the high concentration of fluoride in drinking water is suspected to be the cause of dental fluorosis within the areas. However, contemporary researchers and several epidemiological studies have shown that mild to severe form of Dental fluorosis is usually associated with fluoride concentration in drinking water. This could be seen from the result that 60% of the total samples analysed from these communities had high fluoride concentrations even greater than 1.4mg/litre apart from other sources of fluoride intake through foods and fluoridated dental products. Consequently, according to Dean (1942), Fluoride levels in drinking water at concentrations between 0.9 and 1.2 mg/litre can give rise to mild dental fluorosis with prevalence of 12-13%. No doubt, in another recent large-scale survey carried out in Japan by Tsutsui *et al*. (2000) on the prevalence of dental fluorosis in Japanese communities exposed to naturally occurring fluoride up to 1.4mg/litre. A total of 1,060, 10-12 year-old, life time residents were examined and the prevalence of dental fluorosis was found to increase as fluoride levels increased, ranging from 1.7 percent at 0.2 – 0.4 mg/litre up to 15.4 percent in the group exposed to 1.1 – 1.4 mg/litre.

FINDINGS

The study has revealed high fluoride levels in drinking water in some parts of Kaltungo local government area, although, some of the results are within the WHO recommended standard of 1.5 mg/litre. The results further showed that borehole samples are richer in fluoride than corresponding well water samples. The reason for this could be that possibly, the solubility of fluoride minerals increases with depth (Smith, 1983). These high levels of fluoride are therefore, the cause of dental fluorosis (tooth mottling). The follow up survey on the hand, found the relationship between high fluoride concentrations in drinking-water and cases of bone fracture resulting from accidents. This study actually confirmed that high levels of fluoride in drinking- water increase the percentage of teeth mottling as well as cases of accidents with fracture within the locality. However, in some locations like Kaleh-Aya and Okra, the percentage of tooth mottling are high but the percentage of accidents with fractures were found to be extremely low. This shows that the fluoride effect is more on the teeth than the bone. In conclusion, high fluoride levels in drinking water could cause tooth mottling, dental caries and weak bones as seen from this study.

Acknowledgement The authors are grateful to Gombe State University for providing funding the research.

REFERENCES

Brunelle, J.A. and J.P. Carlos, 1990. "Recent Trends in Dental Caries in U.S. Children and the effect of water Fluoridation," National Institute of Dental Research National Institutes of Health, *Journal of Dental Research,* Vol. 69, *PP 723 – 727*

Chen C.J *et al*. 1988. (A Nationwide Survey on Drinking Water Quality and Waterborne Disease in Chine.) Beijing, Institute of Environmental Health and Monitoring, Chinese Academy of Preventive medicine, India. CRS: Congrational Research Service (2006), Retrieval date 07/02/2010. CRS Website.

Dean HT 1942. Epidemiological Studies in the United State. In: Moulton FR, ed. Fluoride and Dental Health. Washington D.C. *American Association for the Advancement of science* (AAAS Publication No. 19)

Fawell J, Bailey K, Chilton J, Dahi E, Fewtrell L, Magara Y 2006. "Environmental Occurrence, geochemistry and exposure" (PDF). Fluoride in Drinking- Water. World

Health Organization *PP. 5-27 ISBN 92-4-15619-2.* Http://www.who.int/water-sanitation

Jenny, A.A., Rezende, K.M.P.C., Macrocho, S.M.S; Alves, F.B.T, Celeberti; P; Ciamponi A. L 2009. "Dental Fluorosis: Exposure, Prevention and Management." Med Oral Cir Bucal 4(2): E103-7

Li Y *et al*. 2001. Effect of Long-Term Exposure to Fluoride in drinking water on risk of bone fractures. *Journals of Bone and Mineral Research* 16 (5): 932 – 939

National Research Council 2006. Fluoride in Drinking Water. National Academic Press *PP430-353* ISBN-309-10128-X

Smith F.A. 1983. Overview of Fluorides in Everyday life. Shup J.L. Peterson H.B. and Leone H.C. (Eds) Fluorides. Effects of vegetation, animals and human paragon press inc., Salt Lake city, Utah: 7-20

Tsutsui, A., Yagi, M and Horowitz, A.M. 2000. The Prevalence of dental caries and Fluorosis in Japanese Communities with up to 1.4ppm of naturally Occurring Fluoride. *Journal of Public Health Dentistry*, 60 (3), 147-153.

Water forum 2003. Water quality forum: What is the ADA's interim Guidance on infant formula and Fluoride? American Dental Association. Website Accessed May, 28, 2008. Htt:*II*www.ada.org/public/topics/fluoride/infantsformula-faq.asp#2

WHO 1971. International Drinking Water Standard 3rd Edition Geneva, WHO

Wikipedia Encyclopedia 2009.

Wongdem, J.G., Aderinokun, G.A. Sridhgar, M.K. and Selkur, S. 2001. Prevalence and distribution pattern of enamel fluorosis in Langtang town, Nigeria. *African Journal of Medicine and Medical Science* 30,143-140.

****