American-Eurasian J. Agric. & Environ. Sci., 6 (4): 417-420, 2009
ISSN 1818-6769

Fluoride Concentration in Malaysian Drinking Water

[1]Mohd Sham Shaharuddin, [2]Yusoff Mohd Kamil, [2]Yaziz Mohammed Ismail,
[2]Ramli Mohammad Firuz,[1]Ismail Syazwan Aizat and [1]Abdullah Mohd Yunus

[1]Department of Community Health, Faculty of Medicine and Health Sciences,
Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
[2]Department of Environmental Sciences, Faculty of Environmental Studies,
Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

Abstract: This study aimed at determining the mean concentration of fluoride in drinking water from nine sites in Malaysia. Three sites were in Selangor, one each in Perak, Melaka, Kelantan, Terengganu and the Federal Territory of Kuala Lumpur and one in Kota Kinabalu, Sabah. A total of 689 households were chosen from which a total of 2067 water samples were collected. They were obtained from two sources – treated piped water from water treatment plants (WTPs) and groundwater extensively used for cooking and drinking purposes. Samples were collected from pipes at homes or water buckets from wells. They were then stored in pre-cleaned HDPE bottles and were analysed within the next 72 hours using a direct reading spectrophotometer model DR/2010 HACH Brand. Results showed that the mean concentration of fluoride in Sri Serdang, Selangor was the highest, at 0.71 + s.d 0.12 mg/L, while the concentration of fluoride in the samples from Kota Kinabalu had the lowest mean concentration of fluoride, at 0.08 + s.d 0.06 mg/L. Kelantan, Terengganu and Sabah states have ceased fluoridation of treated water in the wake of higher cases of dental fluorosis amongst the population, which explained the lowest mean concentration of fluoride from sites in these states. The mean concentrations of fluoride in the majority of samples were lower than the concentration recommended by the health authorities i.e. 0.5 – 0.7 mg/L, hence insufficient for eradicating dental caries. This was the main reason why fluoride has been added into treated water. However, higher concentrations of fluoride i.e. 1 mg/L or more may alleviate the occurrence of dental fluorosis, especially among children.

Key words: Fluoride · Drinking water · Fluoridation · Dental caries · Malaysia

INTRODUCTION

Fluoride played a key role in caries prevention for the past 50 years but excessive ingestion of fluoride during tooth development may lead to dental fluorosis [1]. Fluoride (F-) is anelectronegative element, widespread in the earth's crust at a concentration of 0.06 to 0.09 %. This element is present in an adult human being at a concentration of 2.6 g and is important in the mineralisation process, which is to strengthen the teeth and bones. There are some evidence showing fluoride in low daily doses may affect the metabolism of bacteria believed to be responsible for dental caries, but this effect is minor [2]. The usage of fluoride has been very important in reducing dental caries and also to prevent osteoprososis. Even so, a correct dosage is important so as to prevent fluorotoxicosis.

A less important benefit is that fluoride may also help to reduce the metabolic activity of bacteria. These three benefits result from having small amounts of fluoride present in the oral environment through its topical application [3]. The presence of fluoride under acid conditions encourages the formation of fluorhydroxyapatite and hence remineralisation of the enamel surface. Fluorhydroxyapatite is less soluble than hydroxyapatite and thus prevents further demineralisation of tooth enamel. Dental fluorosis results from exposure to fluoride in children during the time of tooth formation. Radiographically detectable mineralization of the primary incisors occurs by 24 months of age and prior to 6 years

Corresponding Author: Ismail Syazwan Aizat, Environmental and Occupational Health Unit, Department of Community Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
E-mail: syazwan@medic.upm.edu.my

of age for the second molars and premolars. Therefore, dental fluorosis does not occur when exposure occurs in children older than 6 to 7 years of age [4].

Fluoridated public drinking water system is by far the most effective way to ensure healthy teeth of the community. This is because water is the main nutrient for humans and fluoride readily dissolves into water. Fluoridated drinking water can be classified as a diet that influences the prevention of tooth-related diseases [5]. Fluoridation of public drinking water system is the last segment in the process of turning raw water from the river into potable water suitable for human consumption. Before the processed water is sent into holding tanks, fluoride in the form of sodium fluoride (NaF) or hydrofluoric acid (HF) is added into the water. Normally, the levels of fluoride that reach households range from 0.5 mg/L to 1.0 mg/L.

Ingestion of water containing 1.0 mg/L or less of fluoride during tooth calcification may contribute to the emergence of dental fluorosis, but it was not categorized as serious [6]. At a fluoride level of 0.9 mg/L to 1.2 mg/L, very mild fluorosis occurs [7]. The aim of this article study is to determine the level of fluoride in water samples collected and to ascertain whether the levels are above or below the levels recommended by the health authorities.

MATERIALS AND METHODS

A total of 689 households took part in this study, which was a part of wider study to determine the levels of fluoride in drinking water and whether there were any significant relationships to dental fluorosis. A total of 8 states in Malaysia were selected randomly in determining the location areas for water sampling. From 8 states of Malaysia selected, several location in the district was purposively sample to represent the state of study location, where the main criteria was the water is used both for drinking and cooking.

Drinking water samples were collected using pre-cleaned HDPE bottles for 3 consecutive days and were analyzed within 72 hours using the SPADNS method on a direct reading spectrophotometer HACH Brand model DR/2010. The areas chosen in each state for this sampling is shown in Figure 1.

The SPADNS method is used to determine fluoride levels in water samples. It involves the reaction of fluoride with a red zirconium-dye solution. This method is accepted by the United States Environmental Protection Agency (USEPA) for reporting for drinking and wastewater analysis [8].

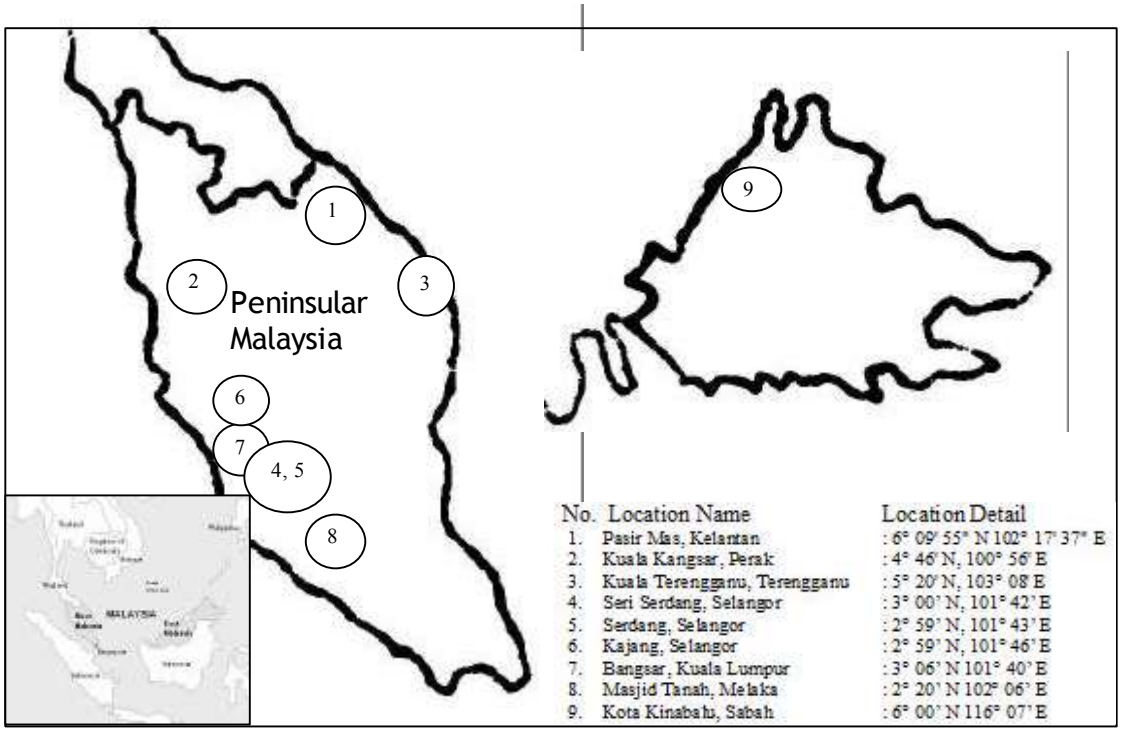

Fig. 1: Location of study sites. Inset: Location of Malaysia in Southeast Asia

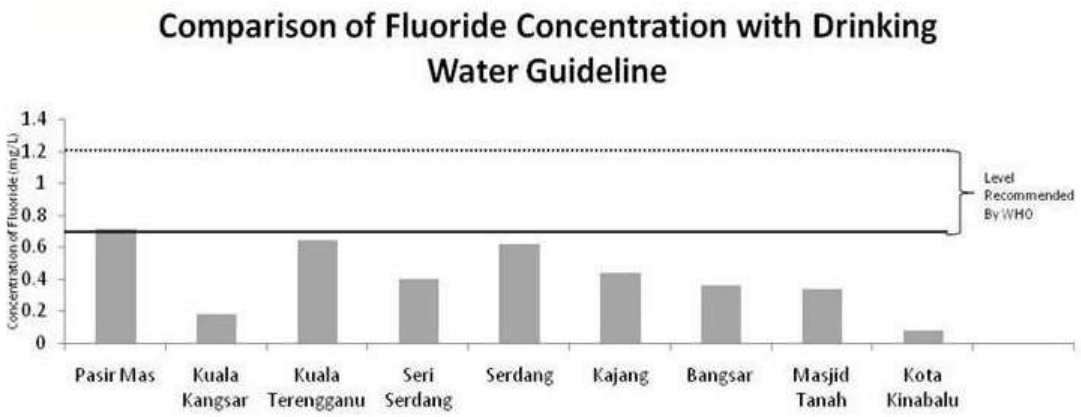

Fig. 2: Comparison of the Mean Concentration of Fluoride with the Guideline

Table 1: Water Samples and Number of Samples

No.	Region	State	Sampling Location (District)	Number of samples
1	North	Kelantan	Pasir Mas	255
2		Perak	Kuala Kangsar	225
3		Terengganu	Kuala Terengganu	249
4	Central	Selangor	Seri Serdang	162
5			Serdang	159
6			Kajang	225
7		Kuala Lumpur	Bangsar	255
8	South	Melaka	Masjid Tanah	186
9	Others	Sabah	Kota Kinabalu	381
			Total	2067

Table 2: The range and means of fluoride in water samples

No.	Area	Range of Fluoride level (mg/L)	Mean of Fluoride level (mg/L)
1	Pasir Mas	0.68-0.89	0.71±sd 0.12
2	Kuala Kangsar	0.03-0.30	0.18±sd 0.06
3	Kuala Terengganu	0.55-0.80	0.64±sd 0.07
4	Seri Serdang	0.12-0.90	0.40±sd 0.16
5	Serdang	0.35-0.81	0.62±sd 0.09
6	Kajang	0.24-0.85	0.44±sd 0.02
7	Bangsar	0.05-0.78	0.36±sd 0.16
8	Masjid Tanah	0.07-0.62	0.34±sd 0.13
9	Kota Kinabalu	0.00-0.36	0.08±sd 0.06

Significant different with all sampling taken, sd=standard deviation

RESULTS

A total of 2067 samples were analyzed for fluoride level in all selected areas (Table 1). The range and means of fluoride in water samples can be seen in Table 2. All the data of fluoride concentration was calculated based on its respective area and the mean of the result presented in Table 2. Figure 2 showed about the level of the fluoride concentration in location selected and the level recommended by WHO.

DISCUSSION

Mean fluoride levels in all 9 study sites were lower or within the level recommended by the Ministry of Health, Malaysia, which is at 0.5 – 0.9 mg/L. The highest fluoride level was found in Seri Serdang, Selangor with a mean of 0.71 + sd 0.12 mg/L, while the lowest mean was found in Kota Kinabalu, Sabah, at 0.08 + sd 0.06 mg/L. The lowest level was a result of non-fluoridation of drinking water in Kota Kinabalu by the local health authorities. Kelantan, Terengganu and Sabah are three states in Malaysia that does not have artificial fluoridation of drinking water in the wake of higher cases of dental fluorosis amongst the population [9].

A report indicated that 62.2% of the Malaysian public receives processed water with artificial fluoridation and the level was at 0.5 mg/L to 0.9 mg/L [10]. Another study by the Ministry of Health Malaysia in the year 2002 showed that fluoride levels in a few Malaysian states were above the recommended levels and this may be a factor contributing to the highest prevalence of dental fluorosis among the people [11].

A study in Pakistan to map natural fluoride in drinking water, where samples from 987 water supplies were analyzed, showed that 84.0% contained less than 0.7 mg/L of fluoride. This showed a clear indication for use of alternate sources of fluoride to ensure optimal intake necessary for the control of dental caries [12].

In Mexico, a study among 24 rural communities located in a north-western arid region of Mexico where the people used water from underground wells with high fluoride content showed that 77.0% of water samples exceed the maximum fluoride limits (1.5 mg/L) and 79.69% of the population presented dental fluorosis. In communities with fluoride levels over 6.0 mg/L, 84.0% of

the population presented dental fluorosis, while the maximum prevalence was found in the 18 – 30 year age group [13].

The level recommended by WHO is in range (0.7-1.2 mg/L). As shown in the Figure 2, nearly all the maximum levels are below or within the range stipulated by WHO. WHO recommends the concentration of fluoride in drinking water to be less than 1.5 mg/L, after considering intake of water of the population in question and also intake from other sources such as air and food that may approach or be greater than 6.0 mg/day [14]. In an investigation to determine the level of fluoride concentration in a rural district of Togtok county, inner Mongolia Autonomous Region, China, Wang *et al.* [15] found that 62% of wells used for water supply had a fluoride level of higher than 1.5 mg/L and the highest value was 8.0 mg/L. There were signs of dental and skeletal fluorosis in a village where fluoride concentration was extremely severe. Grobleri, *et al*. Louw and van Kotze [16] compared different fluoride levels in drinking water in three locations in South Africa, where they found that the area with fluoride levels of between 2.7 mg/L and 3.3 mg/L contributed to 95.0 % of dental fluorosis occurrence.

CONCLUSION

The mean levels of fluoride in drinking water samples were lower than the level recommended by the health authorities. This may not be enough to prevent or eliminate dental caries, which is the main reason fluoride is added into treated water.

REFERENCES

1. Whelton, H.P., C.E. Ketley, F. McSweeney and D.M. O'Mullane, 2004. A review of fluorosis in the European Union: Prevalence, risk factors and aesthetic issues. Community Dent Oral Epidemiol., 32(Suppl. 1): 9-18.
2. Limeback, H., 2002. Fluoride and dental caries: systemic and topical effects. Fluoride 35(4): 2002-XXVth International Society for Fluoride Research (ISFR) Conference Abstracts.
3. Ellwood, R.P., 2006. Fluorosis Revisited. British Dental Health Foundation: Word Of Mouth – Dental Health and Practice 2006 Website. http://bdhf.atalink.co.uk/articles/71
4. Ishii, T. and G. Suckling, 1986. The appearance of tooth enamel in children ingesting water with a high fluoride content for a limimted period during early tooth development. J. Dent. Res., 65: 974-977.
5. Ericsson, Y. and U. Ribellius, 1971. Wide variations of fluoride supply to infants and young children. Pediatr. Dent., 1: 44-54.
6. Jackson, R.D., S.A. Kelly, B.D. Katz, J.R. Hull and G.K. Stookey, 1995. Dental Fluorosis in caries prevalences in children residing in communities with different level of fluoride in the water. Journal Public Health Dental, 55(2): 79-84.
7. World Health Organization – WHO 1997. Fluorides and oral health: Report of a WHO expert on oral health status and fluoride uses. WHO, Geneva. 2-8.
8. HACH Company USA 2003. SPADNS method for determining fluoride in water, wastewater and seawater: Method 8029.
9. Ministry of Health, Malaysia 2001. MOH report on National Oral Health Plan Seminar,
10. Ministry of Health, Malaysia 1996. Yearly report. Kuala Lumpur, Malaysia.
11. Ministry of Health, Malaysia, 2002. Yearly report. Engineering Section, Kuala Lumpur, Malaysia.
12. Ayyaz, A.K., H. Whetton and D. O'Mullane, 2002. A map of natural fluoride in drinking water in Pakistan. Int. Dent. J., 52(4): 291-7.
13. Rodriguez-Dozal, S., M.T. Alarcon-Herrera, E. Cifuentes, L.H. Sanin and A. Barraza, 2003. Water fluoride concentration and dental fluorosis prevalence in a north-western arid region of Mexico. Fluoride, 36(1): 70-72. XXVth ISFR Conference Abstracts.
14. World Health Organization 2004. Fluoride in Drinking Water: Background development of WHO Guidelines for Drinking-Water Quality. www.who.int/water_sanitation_health/dwq/chemicals/en/fluoride.pdf
15. Wang, X.C., K. Kawahara and X.J. Guo, 1999. Fluoride contamination of groundwater and its impacts on human health in Inner Mongolia area. J. Water SRT – Aqua 48: 146-153.
16. Grobleri, S.R., A.J. Louw and T.J. van Kotze, 2001. Dental fluorisis and caries experience in relation to three different drinking water fluoride levels in South Africa. Int J Paediatr Dent., 11(5): 372-9.