American-Eurasian J. Agric. & Environ. Sci., 15 (12): 2354-2357, 2015
ISSN 1818-6769

DOI: 10.5829/idosi.aejaes.2015.15.12.12624

A Comparison of Two Methods for the Evaluation of Fluoride Level in Public Water Supply

[1]Mohd Idrus bin Abdul Shukor, [2]Che Hasnan bin Che Mahmud and [2]Wan Mohamad Sirezi B Wan Omar

[1]Drinking Water Quality Surveillance Programme, Kelantan State Health Department, Malaysia
[2]Pasir Mas District Health Office, Malaysia

Abstract: This study aims to compare between two methods that was widely used in determining level of fluoride in public water supply. Forty three (43) samples of public water were taken in this study involve three different types of sampling points which are Treatment Plant Outlet (TPO), Service Reservoir Outlet (SRO) and Auxiliary. Samples were tested for fluoride In Situ using SPANDS method and also was taken to Chemistry Department for standard analysis method. From all 43 samples that was analysed, mean fluoride level for In Situ testing was 0.0907±0.075mg/l whereas for fluoride level tested by chemistry department mean was 0.1512±0.114mg/l. Both results fall below the level recommended by Ministry of Health Malaysia which is between 0.4mg/l to 0.6mg/l as well as value recommended by WHO (1.5mg/l). Only four samples tested from chemistry department shows value within recommended level. Analysis results from chemistry department seem to produce higher values as compared with analysis results from In Situ testing using SPANDS method (r_s = 0.628, p (0.000). SPANDS method or analysis of fluoride might not be suitable for *In Situ* testing as small error in reagent condition can affect the result of analysis. Therefore analysis of fluoride should be done in control condition.

Key words: Fluoride · Drinking Water · Malaysia · SPANDS

INTRODUCTION

Fluoride is one of the mineral that commonly found in earth crust. Its function in reducing a number of tooth decay was first described by Dentist Dr Frederick McKay in Colorado. According from his study, Dr Frederick found that rates of tooth decay are much more lower in area with fluoride tooth staining [1]. Tooth mottling was extremely rare at fluoride level below 1.0 mg/l, while fluoride level at 1.0 mg/l shows effective use in reducing carries especially among children [1]. Low daily dose of fluoride may affect the metabolism of bacteria believed responsible for dental carries however the effect is still minor [2]. Followed by that first artificially fluoridation in public water supply was done at Grand Rapids, Michigan on 25th January 1945 [1]. Fluoridated public drinking water supplies is by far the most effective way in order to produce a healthy teeth since water is the main nutrient for humans and fluoride readily dissolves in water [3].

Drinking water supply is typically largest single contributor for daily fluoride intake [4]. In 20th century, water fluoridation became one of the most important Public Health Advances [1]. As for Malaysia, first public water fluoridation programme start in Johor on 1972 [5]. Ministry of Health, Malaysia through Oral Health Division has included water fluoridation as part of their National Oral Health Plan 2011-2020. According to report from Oral Health Division, Ministry of Health Malaysia, since its implementation, number of population that receive fluoridated water increase from 70% in 2005 [1] to 75.5% in 2009 [5] and 77.2% in 2012 [6]. However these figures may be limited because there are major differences between urban area with fully piped supplies and rural area that using wells and boreholes [7].

In Kelantan, a number of populations that receive fluoridated water still low compared with other states in peninsular Malaysia. Until 2012 only 14.5% of population in Kelantan receive fluoridated water that came from three water treatment plants that incorporate with fluoride feeder [6].

Corresponding Author: Mohd Idrus bin Abdul Shukor, Drinking Water Quality Surveillance Programme, Kelantan State Health Department, Malaysia.

In order to control the fluoride level in drinking water, World Health Organization (WHO) set guideline values not to be more than 1.5mg/l [8]. WHO find that level of fluoride more than 1.5mg/l was associated with tooth mottling while level fluoride more than 10mg/l have a potential to cause crippling skeletal fluorosis [7]. Some studies also indicated that mild fluorosis can also occur at fluoride level 0.9mg/l to 1.2mg/l [9]. However studies conducted on 2010 in Malaysia indicate that there's no relationship between fluoride level in drinking water and scored fluorosis [3]. Although fluoride level in drinking water supplies was set by WHO at level 1.5mg/l, it still can be adapted for local condition. In order to set up standard for fluoride in drinking water supplies, such condition like climate and volume of water intake need to take into consideration [7].

In Malaysia level of fluoride in drinking water was set between 0.4mg/l to 0.6mg/l [10]. According to report from Oral Health Division Ministry of Health, in 2012 out of 1462 samples taken, only 100 samples (6.8%) achieve level of fluoride within this range [6]. However this result slightly higher compared to report from Drinking Water Quality Surveillance Programme, Ministry of Health. According this report out of 261 samples tested, only 3 (1.15%) achieve level 0.4mg/l to 0.6mg/l [11]. Different study that have been conducted by universities shows level of fluoride that reach households can range from 0.5mg/l to 1.0mg/l [12]. Difference in this result might be due to different number of samples as well as method of analysis that was used. Based on current studies Oral Health Division, Ministry of Health suggest level of fluoride in treated water need to maintain at 0.5mg/l [6].

The objective of this study is to compare two different methods of estimating fluoride level in Public Water Supply distribution system

MATERIALS AND METHODS

A total of 43 samples were taken from three different type of sampling point which is Treatment Plant Outlet (TPO), Service Reservoir Outlet (SRO) and Auxiliary (Aux). Compared with previous study that use water samples from household [3, 12], this study will directly measure amount of fluoride from the mainline of drinking water supply thus eliminate any effect from household water samples such as pipe condition as well as storage tank [13]. This study was done between July and October 2014 in Pasir Mas District.

Analysis In Situ was done using SPANDS (Sodium 2-(Parasulfophenylazo)–1,8–Dihydroxy–3, 6–Naphthalene Disulfonate) colorimetric method [14]. In this method, fluoride reacts with the dye lake, dissociating a proportion into a colourless complex anion (ZrF6 2–) and the dye. SPANDS method was accepted by United States Environmental Protection Agency (USEPA) for reporting drinking and wastewater analysis [14]. As the amount of fluoride increases, the colour produced becomes progressively lighter. After preliminary distillation, the distillate is reacted with the zirconium- dye lake and measured using HACH Pocket Colorimeter II Fluoride [14]. Calibration and standardization of this method was done prior to analysis to minimize error. SPANDS method cover fluoride range from 0.1mg/l to about 1.4mg/l [15].

Prior to *In Situ* analysis using SPANDS method, water samples also collected and sent to chemistry department for further analysis. Here in chemistry department, analysis was done using ion chromatography based on Standard Methods For Examination of Water and Wastewater (APHA 4110B) [16]. Sample was collected using plastic bottles and the bottles must be thoroughly cleaned and rinse with reagent water. No sample preservation was added but sample was keep cool and analysis must be done within 28 days [7].

RESULTS

A total of 43 samples were analysed (three samples from treatment plant outlets, 26 samples from service reservoir outlets and 14 samples from auxiliary). The range and means of fluoride in water samples can be seen in Table 1. Based on this result number of samples that achieve fluoride level within target (0.4mg/l to 0.6mg/l) [10] was presented in Table 2. The correlation between fluorides levels tested In Situ with fluoride level that was tested by chemistry department was presented in Table 3.

Since r_s = 0.628, there is a positive relationship between levels of fluoride tested In Situ with fluoride level that was tested by chemistry department. Since p (.000) $<\alpha$ (.01), there is a significant relationship between fluoride level tested In Situ with fluoride level that was tested by chemistry department. Fluoride level that was tested by chemistry department produces more high value compared with fluoride level from In Situ testing.

Table 1: Range and means of fluoride in water samples

		In Situ Testing		Analysis by Chemistry Department	
Point	Number of Samples	Range of Fluoride (mg/l)	Mean Fluoride level (mg/l) SD	Range of Fluoride (mg/l)	Mean Fluoride level (mg/l)
Treatment Plant Outlet	3	0.06 – 0.19	0.1233±0.065	0.10 – 0.10	0.1±0.00
Service Reservoir Outlet	26	0.00 – 0.28	0.1092±0.085	0.10 – 0.50	0.1846±0.138
Auxiliary	14	0.00 – 0.12	0.0493±0.035	0.10	0.10
Total	43	0.00 – 0.28	0.0907±0.075	0.10 – 0.50	0.1512±0.114

SD: Standard Deviation

Table 2: Number of samples that achieve fluoride level within target

		Results Falls Within Range (0.4mg/l – 0.6mg/l)	
Point	Number of Samples	In Situ Testing	Analysis by Chemistry Department
Treatment Plant Outlet	3	0	0
Service Reservoir Outlet	26	0	4
Auxiliary	14	0	0
Total	43	0	4

*Percentage of samples fluoride within target range (9.30%)

Table 3: Correlation between fluorides levels tested In Situ with fluoride level that was tested by chemistry department

Correlations				
			Fluoride (IN SITU)	Fluoride (Result Makmal)
Spearman's rho	Fluoride (IN SITU)	Correlation Coefficient	1.000	.628**
		Sig. (2-tailed)	.	.000
		N	43	43
	Fluoride (Chemistry Department Results)	Correlation Coefficient	.628**	1.000
		Sig. (2-tailed)	.000	.
		N	43	43

**. Correlation is significant at the 0.01 level (2-tailed).

DISCUSSION

Pasir Mas was selected in this study since only public water supply from this district that contain fluoridated water according to the report from Kelantan State Health Department [11]. From all 43 samples that was analysed mean fluoride level for *In Situ* testing was 0.0907±0.075mg/l whereas for fluoride level tested by chemistry department mean was 0.1512±0.114mg/l. Both results fall below the level recommended by Ministry of Health Malaysia which is between 0.4mg/l to 0.6mg/l [10] as well as value recommended by WHO (1.5mg/l) [8]. Only four out of 43 samples tested from this study shows values between levels recommended by Ministry of Health and all of that from Service Reservoir Outlet (SRO) sampling point which means 9.30% samples falls within target values. In term of percentage comparison, it slightly higher compared to percentage reported in Ministry of Health Oral Division Report which is 6.80% [6] and Drinking Water Quality Surveillance Report which is 1.15% [11]. Difference in this percentage was due to small number of samples use in this study as compared with others two reports.

While, only four samples tested falls within recommended values, all of it comes from sample that was tested by chemistry department. None of samples that were tested In Situ using SPANDS method shows results that falls within recommended values. Analysis using Spearman Correlation shows significant difference in result obtained between these two methods. Analysis results from chemistry department seem to produce higher values as compared with analysis results from In Situ testing using SPANDS method (r_s = 0.628, p (.000).

As comparison, study by Shaharuddin *et al.* [12] which involve analysis of 255 samples taken from Pasir Mas district indicate level of fluoride between 0.68mg/l to 0.89mg/l with mean 0.71±0.12mg/l. Followed by that, another study that was conducted in Pasir Mas on 2010 shows a slightly reduced in fluoride concentration between 0.24mg/l to 0.85mg/l with mean 0.44±0.12mg/l [3]. Both studies use SPANDS method but both didn't do In Situ analysis. Samples were keeping cool and taken back to laboratory for further analysis

Result from this study shows that small error in reagent condition is the most prominent source of error in SPANDS test [7]. As temperature during *In Situ* testing always change, In Situ analysis might not be the good choice for fluoride determination. As for analysis at chemistry department, since the test was done in quiet control temperature, the produced result is much better.

CONCLUSION

The mean levels of fluoride concentration in this study were lower than recommended value by Ministry of Health either tested *via In Situ* SPANDS method or chemistry department. SPANDS method or analysis of fluoride might not be suitable for In Situ testing as small error in reagent condition can affect the result of analysis. Therefore analysis of fluoride should be done in control condition.

REFERENCES

1. Murray, J.J., 2005. A history of water fluoridation., Br. Dent. J., 134(7): 299-302 contd.
2. Limeback, H., 2002. "Fluoride and dental caries: systemic and topical effects," XXVth ISFR Conf. Abstr., 35(4): 244-263.
3. Shaharuddin, M.S., M. Mohd, S. Sumarlan *et. al*, 2010. Dental Fluorosis and Its Relationship With Fluoride Levels in Drinking Water in Three States in Malaysia, Res. J. Med. Sci., 4(1): 20-24.
4. Hardwick, J.L., 1987. Appropriate use of fluorides for human health, 15: 2.
5. Oral Health Division. Ministry of Health, 2011. A Lifetime of Healthy Smiles NATIONAL ORAL HEALTH PLAN FOR MALAYSIA, vol. 2011, no. February.
6. Oral Health Division. 2012. Ministry of Health, Annual Report 2012.
7. Chilton, J., E. Dahi, M. Lennon and P. Jackson, 2006. Fluoride in Drinking-water.
8. WHO, Jan. 2011. WHO guidelines for drinking-water quality., WHO Chron., 38(3): 104-8.
9. Barmes, D.E., 1996. Fluorides and oral health, vol. 13 SUPPL.
10. Drinking Water Quality Standard-Malaysia," 2004. [Online]. Available: http://kmam.moh.gov.my/public-user/drinking-water-quality-standard.html. [Accessed: 29-Mar-2015].
11. Kelantan, J.K.N.**,** 2012. Laporan Program Kawalan Mutu Air Minum.
12. Shaharuddin, M.S., Y.M. Kamil and Y.M. Ismail, 2009. Fluoride Concentration in Malaysian Drinking Water, Am. Eurasian J. Agric. Environ. Sci., 6(4): 417-420.
13. Cochrane, N.J., M.S. Hopcraft, A.C. Tong, H.l. Thean, Y.S. Thum, D.E. Tong, J. Wen, S.C. Zhao, D.P. Stanton, Y. Yuan, P. Shen and E.C. Reynolds, Jun. 2014. Fluoride content of tank water in Australia., Aust. Dent. J., 59(2): 180-6.
14. HACH, 2014. Method 8029 (SPADNS) and Method 10225 (SPADNS2) AccuVac Ampuls ®." pp: 1-6.
15. L.S.C. and A.D.E. Arnold E. Greenberg, 1992. APHA Method 9221: Standard Methods for the Examination of Water and Wastewater, vol. 552.
16. National Environmental Method Index, Analysis of Fluoride - 4110B. [Online]. Available: https://www.nemi.gov/methods/method_summary/7428/. [Accessed: 31-Mar-2015].