FLUORIDE CONTENT OF COMMERCIALLY AVAILABLE READY-TO-DRINK TEA IN BANGKOK, THAILAND

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Abstract. Children in Thailand are consuming more ready-to-drink tea. The fluoride content of this tea needs to be determined to understand its effect on the teeth of those children. We aimed to determine the fluoride content of ready-to-drink tea sold commercially in Bangkok, Thailand. We collected 3 samples of 58 ready-to-drink teas and examined each sample in duplicated using an ion-selective electrode to determine the fluoride content. The Kruskal-Wallis test was used to evaluate differences in fluoride content by tea type with the 95% confidence interval. The mean ± standard deviation (SD) fluoride content was 0.81±0.51 mg/l (range: 0.07-2.15 mg/l). There were no statistically significant differences in fluoride content by tea type (p>0.05). Thirty-nine of the 58 types of tea examines (67%) exceeded the recommended daily intake of fluoride set for children. Consumption of ready-to-drink tea commercially sold in Thailand by children may increase their risk of developing dental fluorosis.

Keywords: beverage, fluoride, fluorosis, tea

INTRODUCTION

Studies have recommended consuming tea daily for the health benefits (Khan and Mukhtar, 2013; Yang and Hong, 2013). Ready-to-drink tea may contain varying levels of fluoride. Increasing consumption of ready-to-drink tea beverages in place of water makes the fluoride content of ready-to-drink tea an important issue among children.

Tea is a major source of fluoride intake in humans (Waugh *et al*, 2016). Fluoride levels in tea are due to various factors, including growing region, season at harvest (Cao *et al*, 2003). Behrendt and colleages (2002) found the tea beverages they examined contained 0.03-3.35 mg/l of fluoride and Kaczmarek (2004) found it contained 0.12-8.33 mg/l of fluoride. Adequate fluoride intake is helpful in preventing dental caries but excessive intake by children may lead to dental fluorosis. The recommended daily intake for children younger than 12 years of age is 0.05-0.07 mg/kg/day (Warren *et al*, 2009).

Fluoride ingestion from consumed beverage may increase the risk of fluorosis (Kiritsy *et al*, 1996) especially in hot climates where more fluids are consumed (Waugh *et al*, 2016). The risk of fluorosis is influenced by both the dose and frequency of exposure (Aoba and Fejerskov, 2002).

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Table 1
Fluoride content of the 58 studied ready-to-drink tea beverages.

Type of tea	Product manufacturer and number of products	The manufacturing nation	Mean±SD (range)
Green tea (*n*=37)	Itoen, 4 products	Thailand	0.84±0.47 (0.41-1.29)
	Kukurin, 2 products	Thailand	0.80±0.19 (0.68-0.92)
	Fujicha, 3 products	Thailand	0.77±0.07 (0.68-1.82)
	Ichitan, 6 products	Thailand	1.15±0.56 (0.50-0.97)
	Oishi, 11 products	Thailand	0.68±0.18 (0.46-0.76)
	My choice, 1 product	Thailand	0.90±0.00 (0.90-0.90)
	D3, 1 product	Thailand	0.81±0.00 (0.81-0.81)
	Unif, 2 products	Thailand	0.84±0.47 (0.41-1.29)
	Manobu, 2 products	Thailand	0.58±0.25 (0.40-0.76)
	San Benedetto, 3 products	Italy	0.10±0.01 (0.09-0.11)
	Pokka, 2 products	Singapore	0.98±0.51 (0.51-1.47)
Black tea (*n*=9)	Ichitan, 2 products	Thailand	0.72±0.03 (0.70-0.74)
	Lipton, 2 products	Thailand	0.47±0.03 (0.44-0.49)
	Unif, 1 product	Thailand	0.82±0.00 (0.81-0.82)
	Kio, 1 product	Thailand	0.70±0.00 (0.70-0.70)
	Pokka, 3 products	Singapore	1.94±0.16 (1.82-2.15)
Oolong tea (*n*=6)	Itoen, 1 products	Thailand	1.46±0.15 (1.44-1.46)
	Suntory, 2 products	Thailand	1.24±0.02 (1.22-1.25)
	Manobu, 1 product	Thailand	0.62±0.01 (0.62-0.63)
	Kio, 1 product	Thailand	0.60±0.01 (0.60-0.61)
	Pokka, 1 product	Singapore	1.50±0.26 (1.47-1.52)
White tea (*n*=6)	Puriku, 4 products	Thailand	0.61±0.56 (0.07-1.14)
	Manobu, 2 products	Thailand	0.60±0.01 (0.58-0.60)

The concentration of fluoride is not displayed on the packing of any ready-to-drink tea beverages in Thailand. Therefore, we aimed to assess the fluoride content of ready-to-drink tea beverages sold in Bangkok, Thailand.

MATERIALS AND METHODS

Fifty-eight samples of ready-to-drink tea beverages in the original plastic bottle were purchased in Bangkok, Thailand. Three samples of each type of beverage were examined in the study. The characteristic of the samples are shown in Table 1. The fluoride concentration of each sample was measured twice using an ion specific electrode (Orion-96-09, Fisher Scientific, Waltham, MA) after buffering with the same volume of TISAB III (total ionic strength adjustment buffer III). The fluoride concentrations were recorded as mean±SD for each beverage. Statistical analysis was used to evaluate the data. The paired *t*-test was used to compare the first and second measurements for each sample. The one-way ANOVA test was used to compare the fluoride content among the batches of the same brand and the Kruskal-Wallis test was used to evaluate differences among the types of tea. A p-value<0.05 was considered statistically significant.

RESULTS

The fluoride content of each of the 58 samples is shown in Table 1. Forty-nine samples (84%) were produced in Thailand. Thirty-seven samples (64%) contained green tea, 9 (16%) contained black tea, 6 (10%) contained oolong tea and 6 (10%) contained white tea. Each sample was examined in duplicate and the 2 results were compared to determine accuracy; there were no significant differences between the 2 results (p=0.22). There were also no significant differences in fluoride content among the three batches for each brand (p=0.16). The fluoride content of the samples tested ranged from 0.07 to 2.15 mg/l. Thirty-nine samples (67%) had a high fluoride content (>0.6 mg/l) and 2 (3.5%) had a low fluoride content (<0.3 mg/l). The averages (±standard deviation) fluoride content in order from least to greatest by type of tea were white tea (0.61±0.44 mg/l; range: 0.07-1.14 mg/l), green tea (0.64±0.29 mg/l; range: 0.09-1.82 mg/l), oolong tea (1.11±0.37 mg/l; range: 0.60-1.52 mg/l) and black tea (1.15 ±0.64 mg/l; range: 0.44-2.15 mg/l). There were no significant differences in the mean fluoride content by tea type (p>0.05). The tested tea with the highest of fluoride content was found in Pokka Ice Lychee Black Tea (2.12±0.03 mg/l) and the tested tea with the lowest fluoride content was Puriku White Tea Hokkaido Melon (0.07±0.00 mg/l).

DISCUSSION

Our results were similar to other studies of fluoride content in commercially sold teas. A study from Taiwan (Shyu and Chen, 2013) found the fluoride content of 78 ready-to-drink tested teas ranged from 0.32 to 2.51 mg/l and a study from Germany (Behrendt *et al*, 2002) found the fluoride content of 34 ready-to-drink tested teas ranged from 0.03 to 3.35 mg/l. The fluoride content of the same brand of tea may vary by where it was produced. In our study, the fluoride content of Lipton tea ranged from 0.44-0.49 mg/l, while studies found differing levels in Poland (0.66 mg/l), Sri Lanka (0.32-1.66 mg/l), and Brazil (0.17-0.39 mg/l) (Malinowski *et al*, 2008; Shyu and Chen, 2013; Buzulaf *et al*, 2002).

The variations in fluoride levels are due to various factors, including grade and different type of tea, growing region, season at harvest, source of water and differing production processes at different factories (Stannard *et al*, 1991; Cao *et al*, 2003; Malinowska *et al*, 2008).

We found no significant differences in fluoride content by tea type similar to other studies (Cao *et al*, 2004; Hayacibara *et al*, 2004; Malinowska *et al*, 2008). In our study, the fluoride content of green tea samples tested was 0.09-1.82 mg/l. A previous study from Thailand evaluating the fluoride content of 10 types of ready-to-drink green tea (Rirattanapong *et al*, 2006) also found a range of 0.10-2.03 mg/l.

The optimal fluoride content for ready-to-drink tea in Thailand has been recommended to be 0.6 mg/l due to the hot climate (Craig *et al*, 2015; Rirattanapong and Rirattanapong, 2016a). In our study, 19 tested samples (33%) had fluoride content lower than 0.6 mg/l. The highest fluoride content found in our study (2.15 mg/l) could increase the risk of developing dental fluorosis in a child aged 1-3 years, if they weighed 10-14 kg (Amanlou *et al*, 2008; Rirattanapong and Rirattanapong, 2016b), having estimated fluoride intake of 0.7-1.00 mg from other sources. In our study, the fluoride contents of studied samples exceeded the maximum recom-

mended level.

There are no regulations requiring putting on the label the fluoride content of ready-to-drink tea beverages in Thailand. We recommend this be done to reduce the risk of fluorosis in children. Dentists and other health care providers should also be aware of the risk for fluorosis in children who consume ready-to-drink tea beverages. Our results show some ready-to-drink tea beverages increase the risk of dental fluorosis if consumed by children.

REFERENCES

Amanlou M, Nabati F, Azizian H, Farsam H. Assessment of fluoride content and daily intake from different brands of tea bags in Iran. *Res Pharmaceut Sci* 2008; 3: 55-9.

Aoba T, Fejerskov O. Dental fluorosis: chemistry & biology. *Crit Rev Oral Biol Med* 2002; 13: 155-70.

Behrendt A, Oberste V, Wetzel WE. Fluoride concentration and pH of iced tea products. *Caries Res* 2002; 36: 405-40.

Buzalaf MAR, Bastos JR de M, Granjeiro JM, Levy FM, Cardoso VE da S, Rodrigues, MHC. Fluoride content of several brands of teas and juices found in Brazil and risk of dental fluorosis. *Rev Fac Odontol Bauru* 2002; 10: 263-7.

Cao J, Zhao Y, Liu j, *et al*. Brick tea fluoride as a main source of adult fluorosis. *Food Chem Toxicol* 2003; 41: 535-42.

Craig L, Lutz A, Berry KA, Yang W. Recommendations for fluoride limits in drinking water based on estimated daily fluoride intake in the Upper East Region, Ghana. *Sci Total Environ* 2015; 532: 127-37.

Hayacibara MF, Queiroz CS, Tabchoury CPM, Cury JA. Fluoride and aluminum in teas and tea-based beverages. *Rev Saude Publica* 2004; 38: 100-5.

Kaczmarek U. pH values and fluoride levels in some tea brands. *Ann Acad Med Stetin* 2004; 50 (suppl 1): 58-61.

Khan N, Mukhtar H. Tea and health: studies in humans. *Curr Pharm Des* 2013; 19: 6141-7.

Kiritsy MC, Levy SM, Warren JJ, Guha-Chowdhury N, Heilman JR, Marshall T. Assessing fluoride concentrations of juices and juice-flavored drinks. *J Am Dent Assoc* 1996; 127: 895-902.

Malinowska E, Inkielewiczb I, Czarnowskib W, Szefera P. Assessment of fluoride concentration and daily intake by human from tea and herbal infusions. *Food Chem Toxicol* 2008; 46: 1055-61.

Rirattanapong P, Rirattanapong O. Fluoride content of commercially available bottled drinking water in Bangkok, Thailand. *Southeast Asian J Trop Med Public Health* 2016a; 47: 1112-6.

Rirattanapong O, Rirattanapong P. Fluoride content of commercially available soy milk in Bangkok, Thailand. *Southeast Asian J Trop Med Public Health* 2016b; 47: 160-4.

Rirattanapong P, Vongsavan K, Surarit R. Fluoride content in ready-to-drink green tea. *Mahidol Dent J* 2006; 26: 153-7.

Shyu TH, Chen JH. Fluoride levels in different types and forms of tea drinks consumed in Taiwan and daily human exposure from tea drinks. *J Food Agric Environ* 2013; 11: 178-83.

Stannard JG, Shim YS, Kritsineli M, Laabropoulou P, Tsamtsouris A. Fluoride levels and fluoride contamination of fruit juices. *J Clin Pediatr Dent* 1991; 16: 38-40.

Warren JJ, Levy SM, Broffitt B, Cavanaugh JE, Kanellis MJ, Weber-Gasparoni K. Considerations on optimal fluoride intake using dental fluorosis and dental caries outcomes – a longitudinal study. *J Public Health Dent* 2009; 69: 111-5.

Waugh DT, Potter W, Limeback H, Godfrey M. Risk assessment of fluoride intake from tea in the republic of Ireland and its implications for public health and water fluoridation. *Int J Environ Res Public Health* 2016; 13: 259.

Yang CS, Hong J. Prevention of chronic diseases by tea: possible mechanisms and human relevance. *Ann Rev Nutr* 2013; 33: 161-81.