CONCENTRATIONS OF FLUORIDE AMONG COMMERCIALLY AVAILABLE MOUTHRINSES FOR CHILDREN IN THAILAND

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Abstract. Dental caries are a major public health problem among children, worldwide. Fluoridated mouthrinses are used to reduce the risk for caries among children, but there is little published data about the concentrations of fluoride in commercially available mouthrinses for children in Thailand. The aim of this study was to determine the fluoride concentrations and pH values of commercially available mouthrinses for children in Thailand in order to guide fluoride mouthrinse use recommendations. We found 19 mouthrinses for children from eight manufacturers commercially available in Thailand and evaluated them for fluoride concentration and pH. We obtained 3 samples of each mouthrinse and conducted each evaluation in triplicate using an ion-selective electrode to determine the fluoride concentration. One-way ANOVA and Tukey's tests with 95% confidence interval were used to determine significant differences in fluoride concentration among the studied mouthrinses. The average fluoride concentrations of the studied mouthrinses ranged from 0.00 ppm (Mondamin® kids, Clinica kid's®, Sunstar® for children) to 106 ppm (Oralmed® Kid). Analysis of variance showed a statistically significant difference ($p<0.05$) in the fluoride concentration among the mouthrinses. Mondamin® kids, Clinica kid's®, Sunstar® for children and Fluocaril® had significantly lower fluoride concentrations than the other brands. The pH values of all mouthrinses analyzed ranged from 3.73 (Listerine® kids, Berry shield) to 8.45 (Mondamin® kids, Grape flavor). Two brands' (Listerine® kids and Mybacin® Junior) pH values were below 5.5. The commercially available mouthrinses studied contained large variations in fluoride concentration and pH values. These mouthrinses should be labeled with their fluoride concentrations and pH values in order to inform dentists on how to advise their patients regarding appropriate use.

Keywords: children, fluoride, mouthrinse

INTRODUCTION

Dental caries are a major public health problem world-wide affecting the majority of adults and children (Petersen and Ogawa, 2016). Fluoride has been used to prevent and treat dental caries and has been a key factor in the decline of dental caries (ten Cate, 2013). The decline in dental caries is as a major public health achievement (Kanduti *et al*, 2016). Fluoride is used in most toothpaste for caries

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prevention (Sebastian and Siddanna, 2015). Fluoride may also be applied to teeth as a mouthrinse to promote remineralization of early carious lesions and inhibit demineralization of tooth enamel (Cheng, 2017).

Fluoridated mouthrinses can be used for caries prevention in adults and children (Marinho *et al*, 2016). Fluoride mouthrinses have been frequently used in school-based programs to prevent caries (Cheng, 2017). The recommended procedure is rinsing the mouth from one to two minutes per day with a mouthrinse containing 0.05% sodium fluoride or every 1-2 weeks with a mouthrinse containing 0.2% sodium fluoride (Zero, 2006).

Dental fluorosis occurs due to excess fluoride ingestion during tooth formation (DenBesten and Li, 2011). Because of the risk of swallowing too much fluoride, fluoride mouthrinses are not recommended for children younger than six years old, because they are unable to rinse their mouth carefully and there is a danger of swallowing fluoride (Arakawa *et al*, 2009).

Multiple sources of fluoride exposure are associated with an increase in the incidence of dental fluorosis (DenBesten and Li, 2011). Therefore, dental professionals need to be aware of the concentration of fluoride found in drinking water, toothpaste, mouthrinses, gels and varnishes to avoid fluorosis from too much fluoride or caries from insufficient fluoride.

Erosion by mouthrinse was first reported by Addy *et al* (1991). Mouthrinses with pH values below 5.5 can cause dental erosion (Pretty *et al*, 2003). Pontefract *et al* (2001) stated that long term usage of mouthrinse can potentially erosive. It is recommended that low pH mouthrinses should be used as short to medium term adjuncts to oral hygiene and never as prebrushing rinses (Pontefract *et al*, 2001).

There is little published data on the concentration of fluoride of commercially available mouthrinses for children in Thailand. Therefore, the aim of this study was to determine the fluoride concentration and pH of commercially available mouthrinses for children in Thailand.

MATERIALS AND METHODS

We were able to find 19 mouthrinses for children from 8 manufacturers commercially available in Thailand and indicated them all in our study: Fluocaril® girl, Strawberry flavor; Fluocaril® girl, Grape flavor; Fluocaril® Green; Fluocaril® Red; Kodomo® kids, Strawberry flavor; Kodomo® kids, Orange flavor; Listerine® kids, Berry shield; Mybacin® Junior, Strawberry flavor; Mybacin® Junior, Orange flavor; Oralmed® Kid, Bubble Gum flavor; Oralmed® Kid, Tutti Fruity flavor; Oralmed® Kid, Green Tea, Apple flavor; Oralmed® Kid, Grape, Resin flavor; Mondamin® kids, Strawberry flavor; Mondamin® kids, Grape flavor; Lion Clinica Kid's®, Grape flavor; Lion Clinica Kid's®, Peach flavor; Lion Clinica Kid's®, Strawberry flavor, Sunstar® for children. We obtained 3 samples of each mouthrinse studies and examined each sample in triplicate.

Fluoride concentration and pH determination

Fluoride concentration was determined using the ORION 96-06 analyzer (VSTAR40A, Thermo Fisher Scientific, Waltham, MA). The studied samples were each mixed with TISAB III buffer solution (1:1 v/v). The pH of each sample was determined using the electrometric method with calibrated Orion 3-Star pH meter (Expotech, Houston, TX).

Analysis of the data

Data were analyzed using the Statistical Package for Social Sciences®, Version 20 (IBM, Armonk, NY). Statistical significance was set at $p<0.05$. The one-way ANOVA and Tukey's tests were used to evaluate differences in fluoride concentration among the studied mouthrinses using a 95% confidence interval.

RESULTS

The studied sample fluoride concentrations and pH values are shown in Table 1. The average fluoride concentrations in the studied mouthrinses ranged from 0.00 ppm (Mondamin kids®, Clinica kid's®, Sunstar® for children) to 106 ppm (Oralmed® Kid) (Table 1). Analysis of variance showed a statistically significant difference ($p<0.05$) in fluoride concentration among the mouthrinses. Mondamin® kids, Clinica kid's®, Sunstar® for children and Fluocaril® all had significantly lower fluoride levels than the other studied brands ($p<0.05$). The pH values of the

Table 1
Fluoride concentrations and pH values of the studied mouthrinses.

Brand	Country of manufacturer	Fluoride concentration in parts per million	Labeled fluoride concentration in parts per million	pH value
Fluocaril® girl, Strawberry flavor	Thailand	60.5±1.9[a]	100	5.82
Fluocaril® girl, Grape flavor	Thailand	61.3±2.9[a]	100	5.70
Fluocaril® Green	Thailand	62.0±3.1[a]	100	5.70
Fluocaril® Red	Thailand	60.0±2.5[a]	100	6.58
Kodomo® kids, Strawberry flavor	Thailand	104.2±1.4[b]	NL	6.14
Kodomo® kids, Orange flavor	Thailand	105.1±1.5[b]	NL	6.19
Listerine® kids, Berry shield	Thailand	103.7±1.3[b]	NL	3.73
Mybacin® Junior, Strawberry flavor	Thailand	102.3±1.8[b]	NL	4.88
Mybacin® Junior, Orange flavor	Thailand	102.5±1.7[b]	NL	4.95
Oralmed® Kid, Bubble Gum flavor	Thailand	103.0±1.5[b]	NL	6.08
Oralmed® Kid, Tutti Fruity flavor	Thailand	105.1±1.5[b]	NL	6.04
Oralmed® Kid, Green Tea, Apple flavor	Thailand	106.0±1.8[b]	NL	6.02
Oralmed® Kid, Grape, Resin flavor	Thailand	105.5±1.3[b]	NL	6.09
Mondamin® kids, Strawberry flavor	Japan	0.00±0.00[c]	None	8.17
Mondamin® kids, Grape flavor	Japan	0.00±0.00[c]	None	8.45
Lion Clinica Kid's®, Grape flavor	Japan	0.00±0.00[c]	None	6.23
Lion Clinica Kid's®, Peach flavor	Japan	0.00±0.00[c]	None	6.23
Lion Clinica Kid's®, Strawberry flavor	Japan	0.00±0.00[c]	None	6.22
Sunstar® for children	Japan	0.00±0.00[c]	None	5.84

Different letters indicate statistically significant differences among groups ($p<0.05$, One-way ANOVA, Tukey's test).

19 mouthrinses analyzed ranged from 3.73 (Listerine® kids, Berry shield) to 8.45 (Mondamin® kids, Grape flavor). Two brands' (Listerine® kids and Mybacin® Junior) pH values were below 5.5.

DISCUSSION

There were only 4 brands that provided fluoride as listed on the label. Three brands (Mondamin® kids, Lion Clinica Kid's, Sunstar for children) contained fluoride at a concentration not different from the manufactures' label values but one brand (Fluocaril®) provided fluoride at a concentration below the manufacturers' label value. Delbem *et al* (2003) found that the fluoride concentration is rarely coincident with the values on the label.

The sodium fluoride concentration of 0.02% (100 ppm) found in most studied mouthrinses was less than recommended limits (0.05%) for daily rinsing (Zero, 2006). However, some studies reported 0.02% rinses was effective in preventing primary caries (Yamane *et al*, 1987; Arakawa *et al*, 2009).

None of the international mouthrinses in our study contained fluoride but contained antimicrobial instead. These antimicrobials were cetylpyridinium chloride (CPC) and xylitol.

None of the studied mouthrinses gave a pH value on the label. The pH of a mouthrinse should be neither too acidic nor too basic (Schuelke, 2015). A pH above 5.5 facilitates tooth remineralization (Schuelke, 2015). Pretty *et al* (2011) reported a low pH mouthrinse can cause dental erosions. Pontefract *et al* (2001) recommended low pH mouthrinses should not be used for long term or pre-brushing.

Dental fluorosis can be prevented in children if the parents and children are educated on the proper use of toothpaste and mouthrinses. However, knowing the fluoride concentration of these products is necessary before giving advice regarding their use.

In this study a variety of fluoride concentrations and pH levels was seen among studied mouthrinses. These concentrations at levels should be on the packaging to allow dental healthcare professionals to give appropriate advice to their patients.

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