

# Comparative Evaluation of Fluoride Uptake Rate in the Enamel of Primary Teeth after Application of Two Pediatric Dentifrices

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## Abstract:

**Statement of problem:** The effectiveness of fluoride dentifrices in reducing dental caries is well documented. However, not all fluoride dentifrices are equally effective

**Purpose:** The objective of this experimental study was to compare fluoride uptake from Pooneh pediatric toothpaste and an ADA-approved pediatric dentifrice, in sound enamel of primary teeth.

**Materials and Methods:** In an in vitro randomized controlled trial, 20 sound primary canines were divided into 2 groups according to the experimental dentifrices. Each tooth was sectioned longitudinally into experimental and control halves. The test groups were treated with dentifrice slurries for 1 hour. All specimens were then suspended in 5ml artificial saliva for 24 hours at 37°C and were etched twice for 30 seconds with a 1ml solution of 0.5M perchloric acid. Fluoride and calcium concentrations were measured by a potentiometer and an atomic absorption spectrophotometer, respectively. The collected data were analyzed using repeated measurement ANOVA and Tukey's test.

**Results:** The mean fluoride concentrations in the Aqua fresh group (4098.44 and 3755.25 ppm in first and both layers respectively) were higher than Pooneh (first layer 2420.51 ppm and both layers 2242.73 ppm), and both were higher than the controls ( $P < 0.05$ ). No significant difference was observed between the control groups. The enamel thickness in Aqua fresh cases was less than the teeth treated with Pooneh (first layer 3.09 vs. 3.85  $\mu\text{m}$ , both layers 4.98 vs. 6.09  $\mu\text{m}$ ) and both were less than the controls ( $P < 0.05$ ). There was no significant difference between the control groups.

**Conclusion:** Fluoride uptake was lower in Pooneh pediatric toothpaste as compared to the tested ADA-approved dentifrice, but considerably higher than the control group.

**Key Words:** Fluoride uptake; Pediatric dentifrice; Enamel; Primary tooth; Potentiometry; Enamel biopsy technique

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## INTRODUCTION

Without doubt the repeated use of fluoride is of critical importance for the control and prevention of dental caries in both children and adults [1]. Although many types of toothpaste include fluoride in their formula-

tion, not all are equally effective [2]. Numerous studies in the past have evaluated fluoride uptake of fluoride dentifrices [3-7], fluoride gels [8-11] and fluoride solutions [12-16]. Delbem et al [11] reported that acidic gels enhance fluoride uptake and improve resis-

tance to caries. Mahmoodian et al [16] in a comparative study on Iranian-made NaF mouthwashes and APF gels, found that the application of both products can enhance the fluoride content of primary teeth.

Sullivan et al [7] compared the anticaries efficacy of a dual-chamber dentifrice to a NaF-silica dentifrice. The dual-chamber consisted of sodium fluoride (NaF) in one component and dicalcium phosphate dihydrate (dical) in the other. They concluded that combining a calcium source with free fluoride, significantly enhances fluoride delivery of NaF when both are mixed just prior to treatment [7].

Most studies have evaluated the efficacy of products manufactured by well-known companies such as Colgate, Crest, Aquafresh and so forth. However the composition and effectiveness of dentifrices manufactured by local companies in many developing countries like Iran are not clearly known.

Numerous brands of commercial toothpastes are manufactured in Iran. Although pediatric dentifrices from multinational companies are also available, their price is much higher than the local products. Therefore Iranian toothpastes, which make claims to have an optimum fluoride concentration, hold the biggest share of the dentifrice market and their anticaries effectiveness would affect the majority of the population in Iran.

The objective of this in vitro study was to compare fluoride uptake from Pooneh pediatric dentifrice and an ADA-approved pediatric toothpaste, in primary teeth.

## MATERIALS AND METHODS

In this in vitro randomized controlled trial, 20 sound extracted primary canines were selected from patients living in Tehran. The children were chosen from the same province in order to make sure that the basic fluoride of the enamel is equal in all specimens [12]. The teeth were cleaned by brushing with deionized water, and stored in 96 percent ethylic alcohol

until used [10].

Considering the fact that primary lesions, cracks and white spots interfere with fluoride uptake, all samples were examined by a stereomicroscope ( $\times 10$ ) to select teeth with sound enamel [12]. The specimens were randomly divided into 2 groups and one of the products was tested in each group. Since parallel points on the tooth have equal fluoride concentrations, each tooth was sectioned buccolingually into experimental and control halves [3,4,9,10,12,13,17].

Semi-circular adhesive discs, with an area of  $14.13\text{mm}^2$  were placed on each tooth half. The entire crowns and roots were covered with acid resistant nail polish. Windows were made on the specimens by removing the adhesive discs. The enamel surfaces were lightly cleaned with deionized water before application of the test dentifrice [18].

### Dentifrice treatments

The test groups were treated with two brands of MFP dentifrices; Pooneh pediatric toothpaste (Paxan, Iran) and Aquafresh pediatric dentifrice (Aqua fresh, USA, 0.15% w/v of F ion).

Supernatants of the two dentifrices were prepared by mixing 10 gm toothpaste with 30 ml deionized water followed by centrifuging at 500 rpm for 30 minutes [4,7,14]. The experimental halves of the two groups received an application of each of the dentifrice supernatants for 1 hour, through the inserted windows [3,4]. To simulate what normally occurs in the mouth during brushing, a constant magnetic stirring was administered during the test process [4,5].

### Fluoride uptake analysis

Each window was thoroughly rinsed with deionized water. It has been shown that synthetic saliva can enhance fluoride uptake [13]. Therefore in order to make the experimental environment closer to normal situations, the specimens were immersed in artificial saliva with the composition of  $\text{NaHPO}_4$  (0.003M),

NaHCO<sub>3</sub> (0.02M), and CaCl<sub>2</sub> (0.001M) for 24 hours at 37°C [8,10,13,14,17].

Fluoride content was assessed using the “enamel biopsy technique” described by McCann [18]. Each specimen was etched twice, for 30 seconds each time, in a test tube containing 1ml of an aqueous solution of 0.5M perchloric acid [3,4,10]. After each etching, the window surfaces were washed with a 2ml solution of 0.2M KOH in the same tube [4,10]. The enamel surfaces were immediately wiped dry with a cotton pellet which was returned to the tube [3,4,10].

In order to determine the fluoride concentration by a potentiometer, EDTA was added to the solution and adjusted the pH of the test tube contents to 5.2 [10,13,20,21]. Calcium concentrations were determined by an atomic absorption spectrophotometer.

Enamel contains 37.4 percent calcium and its density is 2.95, therefore enamel weight and the depth of each etched layer could be determined based on a constant enamel surface area of 14.13mm<sup>2</sup> [3,4,10].

The results were analyzed with repeated measurement ANOVA and Tukey's test.

## RESULTS

The mean and standard deviations of the depth of the first and both layers in the case and control groups and fluoride concentration in enamel are shown in table I and II.

Repeated measurement ANOVA revealed that the average depth of the first and both layers in Aqua fresh group was smaller than Pooneh (P<0.05) and the average fluoride concen-

tration of the first and both layers of Aqua fresh group was higher than Pooneh (P<0.05). According to Tukey's test both fluoride concentration and enamel depth did not show significant difference between the control groups.

## DISCUSSION

Application of a dentifrice is an ideal form of fluoride administration and is routinely used by a large part of the world's population. Very few studies have evaluated fluoride availability and uptake of dentifrices manufactured locally in developing countries.

Itthagarun et al [3] in an in vitro study compared fluoride uptake and free fluoride ion concentration in Thai, Chinese, American and Indian dentifrices. The analysis of fluoride concentration was carried out using the 'acid-etch biopsy technique'. The results indicated that only Colgate MFP2 and Maxam DFP had statistically higher fluoride uptake in all three layers as compared to the controls. No significant difference was observed between the rest of the fluoride dentifrices and controls at any other depth. The average fluoride concentration from both groups dropped considerably in the second and third layers. It was concluded that, when compared to “multi-national dentifrices”, the Thai, Chinese and Indian dentifrices manufactured locally failed to show the fluoride availability and/or fluoride uptake efficacy even though they claimed to contain varying levels of fluoride [3].

Fallahinejad et al [4] performed an in vitro study to compare fluoride uptake in two

**Table I:** The mean (standard deviations) of the depth (µm) of the first layer and both layers.

Group	First layer		Both layers	
	Case	Control	Case	Control
Aqua fresh	3.09 (0.38)	4.84 (0.29)	4.94 (0.54)	6.67 (0.42)
Pooneh	3.85 (0.65)	4.91 (0.31)	6.09 (0.81)	6.76 (0.23)

**Table II:** The mean (SD) of the fluoride concentration (ppm) in the enamel of the first and both layers.

Group	First layer		Both layers	
	Case	Control	Case	Control
Aqua fresh	4098.44 (342.80)	187.70 (32.68)	3755.26 (404.07)	274.28 (30.37)
Pooneh	2420.51 (316.08)	192.13 (17.26)	2242.73 (276.50)	273.62 (11.44)

Iranian (Crend and Nasim) and two ADA approved (Crest and Macleans) dentifrices, using the "enamel biopsy technique". They showed that fluoride uptake was similar or even better in both Iranian products as compared to the ADA-approved dentifrices [4].

Previous studies indicated that the use of sodium fluoride dentifrices resulted in significantly fewer caries than toothpastes containing sodium monofluorophosphate (MFP) [1]. However, sodium fluoride is not compatible with the abrasive materials used in dentifrices such as calcium carbonate ( $\text{CaCO}_3$ ), aluminum oxide ( $\text{Al}_2\text{O}_3$ ) and dicalcium phosphate ( $\text{CaHPO}_4$ ) [22].

In this study both brands of dentifrice contained MFP as the therapeutic agent. The objective of this study was to compare fluoride uptake from Pooneh pediatric dentifrice and Aqua fresh pediatric toothpaste.

According to the results of the present study, despite the fact that fluoride uptake in the first layer of Pooneh toothpaste was considerable, yet it was less than Aqua fresh. As a result the depth of the etched enamel was larger and it was less resistant.

The differences in the depths of the first layers in Aqua fresh and Pooneh, caused etching of the second layers commenced from different depths in two study groups. In order to increase the validity of the investigation, the sum of both layers was used to evaluate fluoride uptake. The results were similar to the findings observed in the first layer.

The lower uptake of fluoride found in the present study might be due to less fluoride release or the decreased amount of fluoride content. Considering that the amount of fluoride in Pooneh toothpaste has not been provided by the manufacturer, further investigation, especially in vivo studies is suggested in order to obtain reliable results.

## CONCLUSION

Although Pooneh pediatric dentifrice showed

less fluoride uptake than Aquafresh (an ADA approved dentifrice), it was significantly higher than control group

## REFERENCES

- 1- Mc Donald R, Avery DR, Dean JA. Dentistry for the Child and Adolescent. 8<sup>th</sup> ed. St Louis: Mosby; 2004, Chap 10.
- 2- Pinkhom JR. Pediatric Dentistry, Infancy through Adolescence. 4<sup>rd</sup> ed. Philadelphia: WB Saunders; 2005, chap 14 and 19.
- 3- Itthagarun A, Wei SH. Analysis of fluoride ion concentrations and in vitro fluoride uptake from different commercial dentifrices. *Int Dent J.* 1996 Aug;46(4):357-61.
- 4- Fallahinejad M, Moini P: In vitro comparison of fluoride uptake from Iranian and standard dentifrices in the permanent teeth. *J Dent Shahid Beheshti University of medical sciences* 2001;19: 140-7.
- 5- White DJ, Faller RV. Fluoride uptake from an anti-calculus NaF dentifrice in vitro. *Caries Res* 1986;20(4):332-6.
- 6- Ripa LW. Clinical studies of high-potency fluoride dentifrices: a review. *J Am Dent Assoc* 1989 Jan;118(1):85-91.
- 7- Sullivan RJ, Masters J, Cantore R, Roberson A, Petrou I, Stranick M, Goldman H, Guggenheim B, Gaffar A. Development of an enhanced anticaries efficacy dual component dentifrice containing sodium fluoride and dicalcium phosphate dihydrate. *Am J Dent* 2001 May;14 Spec No:3A-11A.
- 8- Kohli K, Houpt M, Shey Z. Fluoride uptake by proximal surfaces from professionally applied fluorides: an in vitro study. *ASDC J Dent Child* 1997 Jan-Feb;64(1):28-31.
- 9- Nishioka Y, Nakagaki H, Kato S, Morita I, Kurosu K. Fluoride profiles in different sites of approximal surfaces of second primary molars after topical application of acidulated phosphate fluoride gel in vivo. *Arch Oral Biol* 1995 Dec;40(12):1157-61.
- 10- Biria M, Malekafzaly B, Dehghan F: Comparison of fluoride uptake in the enamel of

- permanent teeth after application of Cina gel and a standard gel. *J Dent Islamic society of Dentists* 2004;Summer:6-14.
- 11- Delbem AC, Cury JA. Effect of application time of APF and NaF gels on microhardness and fluoride uptake of in vitro enamel caries. *Am J Dent* 2002 Jun;15(3):169-72.
- 12- Mok Y, Hill FJ, Newman HN. Enamel fluoride uptake affected by site of application: comparing sodium and amine fluorides. *Caries Res* 1990;24(1):11-7.
- 13- Retief DH, Bradley EL, Holbrook M, Switzer P. Enamel fluoride uptake, distribution and retention from topical fluoride agents. *Caries Res* 1983;17(1):44-51.
- 14- Mellberg JR. Evaluation of topical fluoride preparations. *J Dent Res* 1990 Feb;69 Spec No:771-9;discussion 820-3.
- 15- Eronat C, Eronat N, Alpoz AR. Fluoride uptake by enamel in vitro following application of various topical fluoride preparations. *J Clin Pediatr Dent* 1993 Summer;17(4):227-30.
- 16- Mahmoodian J, Kosari A, Esmaeili B: Fluoride uptake by intact enamel after application of NaF mouthrinsing and APF made in IRAN. *J Dent Med of TUMS* 2001;4:43-49.
- 17- Us Z, Oren C, Ulusu T, Orbey T. In vitro evaluation of fluoride uptake with application of acidulated phosphate fluoride to interproximal enamel of primary teeth using dental floss. *ASDC J Dent Child* 1995 Jul-Aug;62(4):274-8.
- 18- McCann HG. Determination of fluoride in mineralized tissues using the fluoride ion electrode. *Arch Oral Biol* 1968 Apr;13(4):475-7.
- 19- Gu Z, Li J, Soremark R. Influence of tooth surface conditions on enamel fluoride uptake after topical application of TiF<sub>4</sub> in vitro. *Acta Odontol Scand* 1996 Oct;54(5):279-81.
- 20- Sandulescu R, Florean E, Roman L, Mirel S, Oprean R, Suciu P. Spectrophotometric determination of fluoride in dosage forms and dental preparations. *J Pharm Biomed Anal* 1996 Jun;14(8-10):951-8.
- 21- Hattab FN. Analytical methods for the determination of various forms of fluoride in toothpastes. *J Dent* 1989 Apr;17(2):77-83.