

The Compliance of Selected Toothpastes Beam, Sensodyne, Crest, Unique, Colgate to the Global Standard of Fluoride Content

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Objectives One of the economical ways of dental caries prevention is using fluoride containing toothpastes. For fluoride to be effective in toothpastes, significant amount of fluoride need to be in solution form. Global standard of fluoride content of toothpastes is 1500 ppm (part per million). This study aimed to determine fluoride content of some special toothpastes.

Methods This research was cross-sectional and laboratory study. In this study five brands of different toothpastes including: Crest, Sensodyne, Colgate, Unique, Beam were provided and total fluoride of each was determined using ion-selection method and then the fluoride content of each brand compared to the global standard amount. The data was analyzed by one sample t-test at 0.05 level of significance.

Results Sensodyne had 735 ppm, Beam got 76.12, Colgate got 1195 ppm, Unique got 426 ppm and lastly Crest had 1605.70 amount of fluoride in their composition. Quantitative analysis indicated total fluoride content of Sensodyne, Beam, Unique were significantly below global standard at 0.05 level ($p < 0.05$) in terms of fluoride content whereas total fluoride content of Crest and Colgate had no significant difference with global standard ($p < 0.05$).

Conclusion The results showed that Crest and Colgate met the standard of global fluoride content.

Keywords Toothpastes, Fluorides, Dental Caries, Cariogenic Diet

Introduction

Decay is the most common infectious disease in which the hard tissues of the teeth (enamel and dentin), due to acid secretion, lose their minerals from the decaying bacteria (mainly *Streptococcus mutans*) and gradually disappear. The most important factors accelerating the decay process can be Diet, dental structure, lack of proper hygiene of the mouth and various bacterial species.¹ Various studies show that variable indexes such as DMFT in developing countries and advanced countries, as well as Iran, have high numbers that make the prevention of decay more evident.²

One of the most effective ways to prevent dental caries is to use fluoride-containing toothpastes. For fluoride to be effective in the toothpaste, sufficient amount of it should be available as a solution to protect the enamel structure by preventing the enamel demineralization from the tooth.³ Fluoride containing toothpastes by two methods prevent tooth decay: First, it eliminates the bacteria in the plaque, which produce teeth damping acids and secondly, helps the teeth to get remineralized.⁴

It should be noted that the excessive consumption of fluoride results in development of diseases such as skeletal fluorosis, therefore, accurate use of this substance is necessary.⁵ Fluoride ions become insoluble in combination with other components of the toothpaste over time, especially after the expiration date. Therefore, the concentration of fluoride in the solution of toothpaste decreases during time.⁶⁻⁷ In various studies, fluoride values have been measured in toothpastes in the markets of

different countries such as India, Western Africa, Iran, Chile and Belgium.⁸⁻⁹ The results of some of these studies have shown that fluoride of most toothpastes in developing countries are lower than the standard amounts and the amounts declared by the company and others have reported enough fluoride in toothpastes in these countries.^{8,10-12} However, all studies have reported the amount of fluoride present in toothpaste within the permitted and standard range.¹³

According to this controversy, the present study aimed to investigate the fluoride content of some common toothpaste in the Philippines market and to spot the best to use.

Materials and Methods

This study was a laboratory (in vitro) and descriptive-analytical study of the five fluoride content of the toothpaste in a lab. Easy sampling was done by using the toothpaste in the Philippines market. Selected brands included Crest (American Multinational Procter & Gamble, United States, Canada), Sensodyne (Glaxo Smith Kline, Japan), Colgate (Kantar World panel, United States), Unique (ACS manufacturing, Philippine) and Beam (Guangzhou China Han Oral Products, China) toothpastes. Two tubes of any type of toothpaste with the same production history were tested, so that the bacterial names were named and then the analysis could be performed. Fluoride content in all toothpastes was 1450 ppm according to the manufacturer's claims. The abrasive product for all of these toothpastes, except for the Colgate toothpaste was

Silica. The abrasive product of Colgate toothpaste was CaCO₃. For the beginning, the first two centimeters of each tube were removed due to the probability of not being uniformed in composition and each tube was divided into three equal parts (primary, middle and end) and each part in plastic cans with the same code as the teeth were stored. Each of these three stored parts was sampled and then the total fluoride content of each sample was measured. The fluoride content in the samples of each tube and each brand was calculated in average. All sampling and concentration measurements were performed in the same laboratory conditions by a technician in a private lab.

Total fluoride concentration contains total soluble fluoride concentration plus the concentration of fluoride in insoluble form. Insoluble fluoride deactivated by abrasive toothpaste. To measure the total fluoride concentration, 1 gr of the dentifrices was mixed with 4 gr of deionized water in order to uniformize the composition. Then it was mixed in vortex machine with medium speed for 5 minutes. 65 µl of the mixture was mixed with 52.9 mL chloroform and 10.9mL of deionized water and then was kept For 19 minutes at 29 °C in the incubator AR81 (serial number 0001, code UN09, Pars Azma (Iran, Tehran)). After reaching to environment temperature, 0.5 of NaOH with 0.1 ml of medium TISABIII (Total ionic strength adjustment buffer) was added to the suspension. The amount of fluoride was measured by ion electrode system Measurement 9609 (Thermo Orion, USA). The data of this study was collected through laboratory evaluation of fluoride contents of the toothpastes tested and recorded for each item in the data table. The collected data were then entered into the SPSS software 22 and analyzed statistically. To determine the amount of fluoride in any type of toothpaste and to check the uniform distribution of fluoride ion, any toothpaste of two different production series was randomly selected. Sodium fluoride or sodium monofluorophosphate dental specimens were determined on the basis of related methods. Each experiment was repeated twice. The ion samples were measured using a potentiometric method (potentiometer (Titrande, Metrohm, Switzerland)). Then the results were compared and evaluated.

With the use of descriptive statistical methods including frequency distribution tables, charts and central inclination indexes and dispersion of the studied variables, descriptive and analytic methods were used. Then, a significant difference was found between the content of fluoride and the standard material, using one sample T-test. Finally, statistical analysis of the data was performed using Excel software and SPSS-22 software.

Results

The total fluoride in Sensodyne, Beam, Crest, Colgate and Unique was 735 (part per million), 76/12 ppm, 1605/70 ppm, 1195 ppm, and 426 ppm, respectively. The most fluoride content was Crest toothpaste the percentage change

coefficient (cv%) for these samples was between 0.33 and 7.43, and these results indicated the repeatability of the method on different days. The results of these experiments showed that the coefficient of variation was between 0.7 and 4.5%, and the recovery rate was 80.51. The results are listed in Table 1.

Table 1- Investigating the recovery rate of a potentiometric method for determining the amount of fluoride ion in the toothpastes

Type of toothpaste is formulated	The amount of fluoride added (ppm)	The amount of fluoride ion measured (ppm)	Recovery percentage
A	1000	735	73/5
B	1000	76/12	7/6
C	1000	1605/70	160/57
D	1000	1195	119/5
E	1000	426	42/6
Mean+ SD	1000	504/6+474/9	80/51+61/05

To determine the amount of fluoride in any type of toothpaste and to check the uniformity of ion fluoride distribution, each type of toothpaste of two different production series was randomly selected. For each type of toothpaste, a test was carried out to determine the amount of fluoride ion by a potentiometer six times. Then they were compared and evaluated. The results of this study are listed in Table 2. The obtained results were analyzed using one sample T-test.

Table 2- The results of comparing fluoride concentrations of toothpastes with the FDA standard

Number	Toothpaste	Final mean concentration of fluoride ion (ppm)	Is the amount of fluoride in the toothpaste relevant to the standard
1	Sensodyne	735	no
2	Beam	76/12	no
3	Crest	1605/70	yes
4	Colgate	1195	no
5	Unique	426	no

According to statistical analysis Sensodyne, Beam and Unique toothpastes were significantly below the standard. While Crest and Colgate toothpastes did not have a significant difference with the standard fluoride content.

Discussion

Diets include fluoride levels that are not enough to prevent dental caries. Therefore the consumption of fluoride should be at standard level. The use of fluoride toothpaste has a significant effect on the prevention of dental caries. The fluoride compound of toothpastes is composed of a fluorine element, which is not found in free mode in nature. For all decay preventing dentifrices to be effective accurate amount of fluoride is needed. Research showed that receiving fluoride before tooth decay would reduce the caries in pit and fissures by 66%. Fluoride should continue to be absorbed after tooth eruption.¹⁴⁻¹⁷ The global fluoride standard for toothpastes is up to 1500 ppm.¹⁸ The results of

this study showed that Fluoride content of Crest and Colgate toothpastes did not differ significantly from the standard content and the fluoride content of other toothpastes was lower than the global standard. This finding indicates that in the majority of cases toothpastes have less fluoride content than the global standard. These results are evident in some other findings.⁸⁻¹⁰ The reasons for this may be the failure to comply with standards by the manufacturer and the need to reduce production costs and inadequate oversight by regulatory agencies.

The fluoride content of Colgate, Crest, and Sensodyne toothpastes varies with previous study results in recent studies. The reason for this difference is due to the type of abrasive particles and the compounds present in the toothpaste and the changes in the composition of the products over the years and in different countries, as well as the differences in the components of the study.¹⁹⁻²⁰

Accordingly, this study used a selective ion electrode method that has the ability to measure high-precision paste fluoride^{8,11,21} Most fluoride-containing toothpastes contain sodium fluoride and sodium monofluorophosphate or a combination of the latter.²² Toothpastes containing sodium monofluorophosphate have a higher anti-sputum effect to release more fluoride ions (due to poor covalent bonding between fluoride and phosphate atoms).²³ But since the released fluoride reacts with the calcium ion present in the abrasive, an insoluble compound generates CaF₂, which reduces the anti-decay properties of the toothpaste.^{24,25} Some abrasives in the toothpaste combine to deactivate the ion Fluoride.^{26,27} Silica hydrate, di-sodium pyrophosphate, tetra-potassium pyrophosphate, di-calcium phosphate and cellulose gel are one of the most important types of abrasives. Fluoride free connections with calcium base abrasives in fluoride-containing monophosphate toothpastes to release calcium with fluoride and to form an unstable and

insoluble calcium fluoride compound disable fluoride over all abrasives.²⁸ Regarding these cases, unsaturated silicon dioxide (SiO₂), which is either hydrogenated or gel, and also pyrophosphates under heat, are suitable abrasives.²⁹ Therefore it can be said that it is probably type of abrasive particles which are used in the internal toothpaste structure lead to reduced fluoride releasing level. Colgate toothpaste, despite the high fluoride content, can have less fluoride in the environment due to the use of calcium base abrasives, which will be discussed in terms of its free fluoride content.

Limitations and Suggestions

1. Low number of samples due to the limited cost was not enough to provide accurate information on the composition of toothpaste by the manufacturer (the lack of cooperation of the manufacturing plants) from the limitations of this study.
2. The results indicate a lack of fluoride in most of the toothpastes in the market. Therefore, it is suggested that similar studies be carried out on other toothpastes.
3. Finally, it is suggested that the level of monitoring of toothpaste content be increased by relevant organizations

Conclusion

The result of this study showed that all of the toothpastes except Crest had less fluoride content than global standards, and Sensodyne, Beam and Unique had significantly lower amount of fluoride, while Crest and Colgate toothpastes did not differ much from the global standard.

Conflict of Interests

None Declared ■

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