Estimation of fluoride release in commercial toothpaste

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ABSTRACT

The aim of study is to ensure that the fluoridated toothpaste remain (active) in terms of bioavailability of fluoride in toothpaste.

Seventeenth different brands of toothpastes were collected from the market to determine the concentration of fluoride in the toothpaste. The result indicated that the concentration of fluoride in these products range from 10 p.p.m. to 1000 p.p.m. fluoride. Also, the result revealed that many of these products did not mention the type of abrasive system used to be compatible with the type of fluoride used & to maintain high amount of active fluoride to be benefit by the consumers.

Key words: Fluoride dentifrice, Fluoride toothpaste, Abrasive system, marketing

خلاصة

هند من الدراسة هو معرفة تركيز أيون الفلوريد الموجود في معاجين الأسنان المتوفرة ليبقى القثار فعال في القليل من توس الأنسان.

تم جمع سعة عشر نوعاً من معاجين الأسنان من الأسواق المختلفة لقياس تركيز الفلوريد فيها. 

النتائج أن تركيز الفلوريد في هذه المنتجات كان يتراوح بين 10- 1000 جزء من المليون. 

فلوريد، كذلك، نتائج أن الكثير من هذه المنتجات لم يذكر نوع المادة الممتدة (أو الساطعة) المستخدمة فيها، تكون مثالية مع نوع الفلوريد المستخدم. يمكن الحفاظ على أعلى كمية من الفلوريد حتى يستفاد المستهلك من استخدام هذه المعاجين.

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INTRODUCTION

Dentifrice's are made in three structural forms namely tooth pastes, gels and powders. They provide three important functions. Their abrasive and detergent actions provide efficient removal of debris, plaque, and stained pellicle compared with a toothbrush alone. They polish teeth to provide increased light reflectance and superior aesthetic. Finally, dentifrices act as vehicles for delivery of therapeutic agents like fluoride that provides specific benefits.

Fluoride toothpastes have been proven to be practical and effective way to reduce dental caries. Toothpastes containing fluoride of different types was first introducing over 50 years ago. Clinical trails have demonstrated their effectiveness in reducing caries and because they have been so widely used in many countries, especially in western countries. Fluoride toothpaste has come to play a major part in dental health. The fluoride toothpastes sold in Iraq since late 1970's, and they are only three types of fluoridated toothpastes produced by Iraqi manufacture, Amber and Close up for the adult and Lolo for children use. Other fluoridated toothpastes are also in use, mainly imported from different countries of the world.

The purpose of the study is to ensure that the fluoridated toothpaste remains (active) in terms of bioavailability of fluoride in toothpaste after importing, marketing and during individual usage.

MATERIALS AND METHODS

Seventeenth different brand of toothpastes were collected from the market to determine the concentration of fluoride in the toothpaste. The fluoride concentration in toothpastes was determined using a fluoride ion selective electrode, coupled with a calomel reference electrode. Both were joined to digital pH meter capable of measuring millivoltage of a minimum reproducibility of ±0.2 mv. Prior to fluoride determination, the samples were mixed with 10% by volume of TISAB (Total Ionic Strength Adjustment Buffer) prepared by dissolving 57 ml of glacial acetic acid, 58 grams of sodium chloride and 0.3 grams of sodium citrate in 500 ml of deionised water. The solution was buffered to pH 5.5-5.5 using 5N Sodium hydroxide solution.

The solution was cooled and diluted to make 1000 ml.

Two calibration curves were constructed, to cover fluoride ion concentration (100-1000) ppm and (1-100) ppm. Standard solutions were prepared by serial dilution of 100 ppm prepared by dissolving (55.25) mg of dried sodium fluoride powder in 250 ml of deionized water.

The millilliters of a standard solution was added to 10 milliliter of TISAB. The solution was stirred and the electrode potential in mv was determined.

A calibration curves were constructed on a standard semilogarithmic paper by plotting the millivolt readings (linear axis) against concentration (log axis) measurement. The same 1:1 mixing procedure was used with other standards and with unknown.
RESULTS

The type of toothpaste, concentration of fluoride (ppm), nationality of the products and some notes about the products (if there is any mentioned about presence, concentration of fluoride, presence and type of abrasive material, expired date...) is shown in table (1).

Two products used in this study were from Iraqi manufactures (Close up and Amber) other products are from Jordan (3), Syria (1), Turkey (3), China (5), Thialand (1), and other two products of unknown nationality. The result revealed that the concentration of fluoride in these products range from 10 ppm in Sign toothpaste to 1000 ppm in Sanino smokers toothpaste.

<table>
<thead>
<tr>
<th>No</th>
<th>Type</th>
<th>Fluoride conc. ppm</th>
<th>Nationality</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Close up</td>
<td>620</td>
<td>Iraqi</td>
<td>MFP 0.8%</td>
</tr>
<tr>
<td>2</td>
<td>Amber</td>
<td>760</td>
<td>Iraqi</td>
<td>MFP 0.8%</td>
</tr>
<tr>
<td>3</td>
<td>Diamond Glow</td>
<td>620</td>
<td>Jordan</td>
<td>MFP 1.14%</td>
</tr>
<tr>
<td>4</td>
<td>Trifresh Glow</td>
<td>530</td>
<td>Jordan</td>
<td>Fluoride</td>
</tr>
<tr>
<td>5</td>
<td>Kolynos</td>
<td>350</td>
<td>Syria</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Sanino</td>
<td>700</td>
<td>Turkey</td>
<td>MFP 0.76%+ 0.1% NaF</td>
</tr>
<tr>
<td>7</td>
<td>Sanino/Smokers</td>
<td>&gt;1000</td>
<td>Turkey</td>
<td>Si+NaF</td>
</tr>
<tr>
<td>8</td>
<td>Denicotin</td>
<td>140</td>
<td>Turkey</td>
<td>MFP 0.76%+ 0.1% NaF</td>
</tr>
<tr>
<td>9</td>
<td>Signal/2</td>
<td>720</td>
<td>Turkey</td>
<td>NaF 1000 ppm</td>
</tr>
<tr>
<td>10</td>
<td>Sign/Child</td>
<td>680</td>
<td>China</td>
<td>Ca+Fluorid, ex.</td>
</tr>
<tr>
<td>11</td>
<td>Sinan</td>
<td>680</td>
<td>China</td>
<td>MFP 0.76%+ NaF 0.1%+Ca, ex.</td>
</tr>
<tr>
<td>12</td>
<td>Sign</td>
<td>10</td>
<td>China</td>
<td>Fluoride</td>
</tr>
<tr>
<td>13</td>
<td>Deluxe</td>
<td>780</td>
<td>China</td>
<td>CaCO₃, ex</td>
</tr>
<tr>
<td>14</td>
<td>Guohiling</td>
<td>100</td>
<td>China</td>
<td>CaCO₃</td>
</tr>
<tr>
<td>15</td>
<td>Colgate</td>
<td>200</td>
<td>Thailand</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Flash</td>
<td>20</td>
<td>___________</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>SnowWhite</td>
<td>90</td>
<td>___________</td>
<td>CaCO₃</td>
</tr>
</tbody>
</table>

MFP = Sodium Mono fluorophosphate  
NaF = Sodium Fluoride  
Si = Silica  
Ca = Calcium  
CaCO₃ = Calcium carbonate
DISCUSSION

In addition to other topical fluoride therapy, fluoride toothpastes are the most widely used forms of fluoride therapy in the developed countries. While in the third world countries, the fluoride contained in the toothpastes consider as a practical approach to the problem of delivery topically applied fluoride to a large number of population specially for Iraqi population that rarely use of other fluoride supplements. The vast majority of fluoride toothpastes in the world have involved pastes yielding approximately 1000 ppm (either as 0.76% sodium monofluorophosphate, 0.24% NaF or 0.4% stannous fluoride).

The other ingredients of toothpaste are abrasive, binding agent, humectants, detergents agent in addition to preservative, coloring and sweating agents. Abrasives (cleaning and polishing agents) are the largest ingredient of the toothpaste formula. The most common abrasive system use are calcium carbonate, di-calcium phosphate dihydrate, insoluble sodium metaphosphate, silica, calcium pyrophosphate, sodium bicarbonate and sodium and aluminum silicate. Consideration of the abrasives in fluoride toothpaste formulation is essential because they have the potential to inactivate fluoride, evident by experiments 10,10 and clinical studies 9,11.

Many studies evaluated the rate of loss of fluoride in relation to type of fluoride contain and abrasive system used. As in studies use NaF with abrasive contain calcium, reported reduction of the amount of fluoride availability because of the binding of fluoride by calcium12,13. While other suggest that to improve the anticaries action of NaF by use a more compatible abrasive system 14,15. Many studies use NaF with silica abrasive reported yielding more than 95% of the total fluoride content and had a better clinical anticaries 16,17.

From the finding of the study many of the products only mentioned that contain fluoride (Trifresh, Sign and Deluxe) without specification of fluoride type. While others mentioned the type of abrasive system use only as (Snow white, Guchill). Sanino for smoker reported contain NaF with titanium dioxide and Signal 2 reported contain NaF. So from these products, it is uncertain that the type of fluoride and abrasive system is compatible to maintain the amount of fluoride availability high for improving the anticaries action.

The calcium-containing abrasives were markedly more compatible with sodium MFP than with NaF 10, and Depaola suggested that a formulation with the proper molar ratio of calcium and sodium MFP may have superior cariostatic effect to the currently available formulation 18.

This study revealed that many toothpaste contain NaMFP alone as (Close up, Diamond Glow and Amber), all of these did not mentioned the type of abrasive used, the concentration of fluoride reported in the product was 0.8% for Close up and Amber, while Diamond glow reported 1.14%.

Many studies reported usage of mixed fluoride system (0.76% MFP and 0.1% NaF) and they compare with MFP toothpaste, the results showed that the mixed fluoride systems showed significant reduction in mean caries increments compared with MFP toothpaste 19,20, while other studies reported no differences in efficacy between them 21,22.

From the finding of this study many of the products contain a mixed fluoride system as (Sanino, Sanan, and Demeticin). The result of the study revealed that there was considerable variation in amount of fluoride in toothpastes ranging from 10-1000 ppm. The highest fluoride level was found in Sanino/smoker (>1000 ppm), Deluxe, Amber, Signal 2 and Sanan (>700 ppm) Sanan, Sign for children, Close up, Diamond...
glow (>600 ppm), Trifresh (530 ppm), while other products reported less than 200 ppm. It appear that the Iraqi product (Amber and Close up) contain high amount of fluoride in the toothpaste.

It can be indicated from this finding that there are many fluoridated toothpaste in the market did contain the amount of fluoride that have an effect in reduce dental caries. Also many of these products did not mentioned the type of abrasive system use to be compatible with type of fluoride use and finally to maintain high amount of active fluoride to be benefit by the consumers.

So to enhance the effectiveness of fluoride to reduce the dental caries is by increasing the availability of fluoride ions from specific formulation through improved compatibility of the fluoride active with certain dentifrice components (especially abrasive system).

The prime consideration of the FDA in establishing bioequivalence tests were the potential for fluoride agent abrasive interaction and the maintenance of fluoride activity (availability) over the shelf-life of the product(16). From all the products only three of them (Sinan, Delux and Sign for children) mentioned the expired date of toothpaste. It is important to mention the expired date of any product to make sure that the product is new and fluoride is available in reactive form. In spite of there are some publications proposed rules concerning the long-term availability of fluoride in toothpaste (25,14).

The use of fluoridated toothpaste is very important to decrease the dental caries as they reported in many developed countries (25,26) and as mentioned by Bratthall et al, they revealed the response of 52 experts for the main reasons explaining the caries decline in many western countries over the past 3 decade, they reported that the most effective method was the use of fluoride toothpaste (25).

So any attempt to increase the use of fluoridated toothpaste require the education of the population through the different mass media and involvement and commitment from manufactures, government as well as from those involved in managing and implementing health promotion.

REFERENCES