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REVIEW ARTICLE

Dentifrice: An Aid to Tooth Brushing

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Abstract

Dentifrice is an essential item in day to day oral hygiene practice. It is used, in general, with a tooth brush once or twice a day. There is a vast range of dentifrices for the various pur- poses .These are for cleaning of the teeth by providing the abrasives in it, strengthening of the tooth surface through applying fluoride, providing different medicaments on the tooth surface for dentinal hypersensitivity, preventing tartar deposition with pyrophosphate, whitening of the teeth by incorporating proper abrasives, and bleaching of the discolored teeth through oxidizing agents. Dentists should take a note of the purpose for which the dentifrice is advised to the ailing patients. (2018, Vol. 02; Issue 02: Page 40 - 49)

Key words: Toothpaste, Toothbrush, Plaque biofilm, Tartar, Fluorides, Hypersensitivity, Whitening, Bleaching.

Introduction

Dentifrice is an inclusive term used to de- scribe a powder, paste or gel used with a toothbrush to aid in removal of plaque bio- film, materiaalba and stain from teeth. Dentifrices are daily oral care products, the chemical composition of which is con- stantly changing due to manufacturer's competition. Dentifrices are recognized as the best source of fluoride which most ef- fectively strengthens the enamel to be able to combat against caries. However, fluo- rides are not the only active ingredients in dentifrices. Also important are the clean- ing abilities of dentifrices provided by abrasives, and also the antibacterial qual- ities. These are provided with a variety of substances with different abilities to in- hibit the growth of germs in the oral cavity, as well as a number of ingredients with specific purposes to solve specific prob- lems. The wide selections of dentifrices with various ingredients make it difficult for patients to choose the proper dentifrice and complicate the acquisition of dental products by professionals.

A dental surgeon is the main resource per- son for dental product information for pa- tients. One of the most common questions is, “What is the best toothpaste?” The stock answer is, “It depends”, and then the

dental surgeon tries to assess the need of individual patient and makes an appropri- ate recommendation. The use of fluoride dentifrice is widely acknowledged as a ma- jor reason for decrease in dental caries in many parts of the world. Over the years, dentists have helped patients realize the benefits of oral hygiene, specifically by rec- ommending a tooth brush and dentifrice for the mechanical removal of plaque bio- film. Together with tooth brushes, denti- frices are the most widely recommended and used oral hygiene products, and they offer improved oral health by simple me- chanical removal of plaque biofilm. In more recent years, various agents such as fluoride, pyrophosphate, triclosan, hydro- gen peroxide and calcium carbonate, have been added to dentifrice formulations. The addition of these agents enhances the benefits of the dentifrice delivery system that can now address not only the preven- tion of dental caries and periodontal dis- eases but also whitening, stain removal, oral malodor, calculus formation.

Historical perspectives

From time immemorial man has been us- ing various materials to clean teeth. The Greeks, and then the Romans, improved the recipes of toothpaste by adding abra- sives such as crushed bones and oyster shells (1). In the 9th century, the Persian musician and fashion designer Ziyab in- vented a type of toothpaste, which he pop- ularized throughout Islamic Spain. The exact ingredients of this dentifrice are un- known, but it was reported to have been both "functional and pleasant to taste". It is not known whether these early tooth- pastes were used alone or were to be rubbed onto the teeth with rags, or were to be used with early toothbrushes, such as neem-tree twigs and miswak. Dentifrice or powders came into general use in the 19th century.

Composition of Dentifrice

Basically dentifrice is composed of abra- sives, detergents, water and humectants, binders (thickeners), preservatives, sweet- ening agents, flavouring agents, coloring agents. A brief account of these is hereby given:-

Abrasives

Purpose: Varying particle sizes create an abrasive system that cleans and polishes tooth surface.

Percent: 20 to 40 %

Examples: Calcium carbonate, Calcium pyrophosphate, Aluminum oxide, Silicon oxide, Bicarbonate, Chalk etc.

Comments: Must be compatible with other ingredients, must not damage teeth or soft tissues.

Detergents

Purpose: Help to loosen debris, have foam- ing action, and act as surfactant.

Percent: 1 to 2%

Examples: Sodium lauryl sulfate, Sodium lauryl Sarcosinate

Comments: Some patients have mucosal reaction to Sodium Lauryl Sarcosinate.

Water and Humectants Purpose:

Moistening agent. Percent: 20 to 40%

Examples: Sorbitol, Glycerin,Propylene glycol, Manitol

Comments: Some humectants also add sweet taste and require a preservative to prevent bacterial and mold growth.

Binders (Thickeners)

Purpose: Prevent separation of ingredi- ents.

Percent: 2%
Examples: Alginate, Gum, Synthetic cellu- lose
Comments: High percentage of binders is found in gel formulations.

Preservatives

Purpose: Prevent mold and bacterial growth.
Percent: 1%
Examples: Alcohols, Sodium Benzoate, Di-chlorinated phenols
Comments: Contract allergy occurs in some patients.

Sweetening agents

Purpose: Imparts pleasant flavor. Percent: 2%
Examples: Saccharine, Sorbitol, Mannitol, Xylitol, Glycerin
Comments: Some act as humectants.

Flavoring agents

Purpose: Give immediate pleasant taste sensation that lingers as an after taste.
Percent: 2%
Example: Essential oils (Peppermint, spearmint, wintergreen, cinnamon, men- thol)
Comments: Contact allergy may occur in some patients.

Coloring agents

Purpose: Give attractive and desirable ap-pearance.
Percent: 2%
Examples: Vegetable dyes.
Comments: Must not strain teeth or soft tissues

Classification of dentifrices

In 2012 IIzeMaldupa, AndaBrinkmane, Inga Rendeniece, and Anna Mihailova put forwarded a classification of toothpaste according to certain characteristics of their chemical composition as follows (2):

A. *Caries prevention and treatment*

Toothpaste used as a local fluoride source has the best ability to inhibit the develop- ment of caries (19-27% reduction of car- ies), providing re-mineralization of enamel
(3). Early enamel demineralization is not visible neither clinically, nor with radiolog- ical examination, however in chemical level, carious decay starts from the mo- ment when the normal exchange of miner- als is disturbed, and in most cases the processes of demineralization occurs (4). In the treatment of such early decay, it is important to follow 2 principles: 1) to re- duce the etymological factor (plaque and the bacterial biofilm), 2) To increase the amount of re-mineralizing substances, the concentration of fluoride. These two prin- ciples can be achieved by cleaning the teeth with fluoride toothpaste. The use of fluoride has been shown to be the most ef- fective over the last 20 years; however the regular use of fluoride in early childhood is associated with the development of fluo- rosis.

i. Concentration up to 1000 ppm

In the 1980's, several studies were carried out which showed that children 2-5 years old swallow 30-50% of the toothpaste ap- plied to a toothbrush. These studies were followed by research about the correlation between the fluoride concentration in toothpastes and the spread of fluorosis in permanent teeth. As a, result, due to the risk of fluorosis, it was recommended that children use toothpastes with a fluoride concentration of 500-550 ppm (5). How- ever, not all the study results were equi-pollent. If toothpastes with normal fluo- ride concentration (1000-1500 ppm) were studied it is estimated that they ingest not

more than 0. 1 mg (safe) F per 1 kg body mass per day (6).

ii. FIuoride concentration 1000-1500 ppm

The ability of toothpastes to reduce caries cited in literature varies from 19-27%, however toothpaste with 1000 to 1500 pap concentrations is recognized as the most effective fluoride source (7). Local fluoride sources provide only 10% additional car- ies reduction (8). According to the latest research data, children from 2-3 years of age swallow 48% of toothpaste, but children from 6-7 years of age swallow 25% of toothpaste. In order to reduce the risk of fluorosis in the most susceptible group (4- 6 years of age) it is estimated that they in- gest not more than 0.1 mg (it is safer) F per 1 kg body mass per day (9).

Since it is proven that direct contact of fluorides with the enamel during tooth brushing and the concentration of that fluoride during that contact are most im- portant, it is recommended that younger children use toothpastes with fluoride concentration of 1000 ppm, taking in account the age-appropriate amount. It showed an increased prevalence of fluoro- sis, but theseverity was very mild, and caused neither clinical, nor aesthetic problems. Most studies were done in North America, where water fluoridation has been common since the fluoridation has been common since the 1950's. How- ever, in articles from the last five years, the effectiveness of such reduced fluoride concentrations is more often compared with the effectiveness of normal fluoride con- centration in toothpastes (10, 11). Alt- hough one study shows that the effective- ness of 500 ppm and 1000 ppm toothpastes differed in the caries-active chil- dren's group, in caries-inactive children's groups the effectiveness was the same. In general, use of toothpastes with a fluoride concentration of not less than 1000 ppm is recommended. In addition, it is proven that toothpastes with fluoride concentra- tions of 400-550 ppm do not differ from placebo toothpastes (12, 13). There is also evidence that when using 400 ppm or 1450 ppm toothpastes from 1 year of age, but in strict compliance with the "pea size" amount of toothpaste on a toothbrush, the prevalence of aesthetically noticeable fluo- rosis does not differ between the two groups (14).

There is also some debate about the effectiveness of various fluoride compounds in toothpastes (15, 16). Although *in vitro* studies show that aminofluorides possess the best capacity to re-mineralize enamel. In addition to fluoride, xylitol demon- strates a good anti-caries effect, as well as an antibacterial impact (especially on Streptococcus *mutans*), a salivary stimu- lating effect (enhances salivary buffering effect, reduces sugar clearance time, pro- motes re-mineralization) and direct bio- mechanical effects (prevents enamel min- eral loss). A number of enzymes - lyso- zyme, lactoperoxidase and glycosil oxidase

- have also been proven to work *in situ* against mutant Streptococcus.

iii. Fluoride concentration 2500-5000 ppm

Higher concentrations in toothpastes can achieve a caries reduction of up to 36%

(17). *In vitro* studies also show that tooth- pastes with elevated concentrations have a higher ability to re-mineralize enamel and dentin better than toothpastes with

normal concentrations or placebo tooth- pastes.

B. *Periodontal disease prevention and treatment*

The cause of gingivitis and periodontitis is bacteria in dental plaque, so there are two main rules for the prevention of these dis- eases: 1) to remove plaque regularly, thus preventing the growth of bacteria on the biofilm, and 2) to prevent the growth of bacteria, thus inhibiting formation of plaque and tartar. The first rule is insured by a mechanical cleaning of the teeth, but in order to prevent bacterial growth, man- ufacturers add various antiseptic and an- tibacterial substances to toothpaste - triclosan, chlorhexidine, hydrogen perox- ide, baking soda, Povidone Iodine, zinc cit- rate and others (18).

i. Natural plant extracts, es- sential oils, enzymes or vita- mins (including Ayurvedic)

Toothpastes containing natural plant ex- tracts showed similar antibcterial effec- tiveness as chlorhexidine containing toothpastes (19). The body's immune re- sponse, which takes place in the case of periodontal tissue inflammation, causes damage to the host tissue. Topically used antioxidants may prevent the negative ef- fects of the immune response on tissue without hindering their effect on microor- ganisms (20).

ii. Synthetic antiseptic or antibac- terial substances

The ability of triclosan to lessen signs of gingivitis has been proven in several stud- ies (21). It not only prevents growth of both Gram (+) and Gram (-) bacteria, but also reduces the ability of fibroblast to produce inflammatory cytokines and mediators. Copolymer strengthens the effect of triclo- san. A systematic review of a medium quality also concluded that a triclosan/co- polymer dentifrice provides a more effec- tive level of plaque control than fluoride dentifrice (22). Studies show that triclos- andoes not develop germ resistance and does not change the normal micro flora. It has also been disproven that the use of triclosan-based toothpaste can change the balance of thyroid hormones, however po- tential adverse effects like triclosan adapted cross- resistance with antibiotics still should be investigated. Compared to chlorhexidine it is easier to combine triclo- san with other toothpaste ingredients. It also does not reduce remineralization or diminish the antibacterial quality of fluo- rides .The antibacterial quality of chlor- hexidine is associated the prevention of glucose transport in bacteria cells. Alt- hough the ability of chlorhexidine to in- hibit the growth of pathogenic micro-or- ganisms has been proven, a number of undesirable side effects have been ob- served: 1) pigmentation of teeth and com- posite restoration, 2) dryness and desqua- mation, 3) temporary taste changes, 4) po- tential allergic reactions, 5) intensified for- mation of tartar (23).

C. *For treatment of sensitive teeth*

i. Analgesic toothpastes Toothpastes containing potassium saline maintain a high K+ extracellular level, thus preventing re- polarization of the nerve cell membrane and inhibiting the transmission of impulses without causing changes in the pulp (8, 24).

Improvement was observed in 85% of the cases. Tooth- paste, which is composed of 5% or 10% potassium nitrate, can decrease tooth

sensitivity for up to 4 weeks (25). It is be- lieved that potassium salts also possess oxidizing properties, thus blocking the dentin tubules by crystallizing them, but there is no evidence of this. In other stud- ies even after 30% KNO3 applications, the flow of solution in dentin tubules was only slightly altered, which causes serious doubt about the ability of potassium salt to block the tubules. However the authors of the Cochrane systematic review do not find sufficient evidence of the clinical effi- cacy of potassium salts in the reduction of dentin hypersensitivity (26).

ii. Dentin tubule blocking tooth- pastes

Fluoride compounds, by providing remin- eralization, increase dentin resistance against acids. A precipitation of fluoride compounds is created that blocks dentin tubules (4). Stannous fluoride possesses the ability to block tubules, forming SnF2 and CaF2, and the ability to form a protec- tive layer on the tooth surface, by creating a reaction of Sn2+ ion with sodium, cal- cium and phosphate compounds and forming Sn-Na hexanietaphosphate. It has been proven that with the increase of flu- oride ion concentration in enamel, there is also an increase of enamel microhardness. In addition, by adding calcium and phos- phate ions, they combine with the fluoride ions on the enamel surface and form an amorphous calcium phosphate, which in addition to blocking tubules, also smoothes the tooth surface, achieving an even more effective reduction of sensitiv- ity. However, it is difficult to combine these ions, as they tend to react in the tube of toothpaste, formingnon-effective compounds. As previously mentioned, some authors have discovered that tooth- pastes containing potassium can also block dentin tubules, but they explain this by the presence of abrasives in toothpaste. Even cleaning teeth with distilled water can create a layer of chips which can block the opened dentin tubules. The analgesic effect of toothpaste may also be improved by adding additional substances, the size of whose particles can penetrate the den- tin tubules, and which are stable enough in case of mechanical and chemical irri- tants. For example, *in vitro* studies have proven that toothpastes containing cal- cium sodium phosphosilicate or Novamin block dentin tubules noticeably better than toothpastes with potassium salts. These effects continue even when the tooth is placed in artificial saliva.

Toothpastes containing arginine also yield the good results by blocking the dentin tu- bules. In several studies it has been proven that the clinical hypersensitive ef- fect of arginine is greater than that of po- tassium salts and fluoride. *In vitro* trials with arginine-based toothpaste have shown better blocking of the tubules than with strontium chloride.

Strontium chloride can block the dentin tubules, but in recent literature, evidence of the effectiveness of strontium acetate- based toothpaste is mentioned more often. *In vitro* studies of strontium acetate clearly show better results than arginine and in randomized controlled clinical studies, ac- etate shows markedly higher effectiveness than toothpastes containing sodium fluo- ride and silica dioxide , but only a slightly better effect (p=0.0391,when checking tac- tile sensitivity) than toothpastes contain- ing arginine (27).

D. *Whitening and bleaching tooth- pastes*

Whitening toothpastes are mentioned most often in literature. Their main pur- pose is the removal of plaque, either me- chanically or chemically. However, in some dentifrices there are added chemi- cals that provide a bleaching effect. There are two definite subclasses: a)whitening toothpastes and b)bleaching toothpastes.

i. Whitening toothpaste

By removing stained plaque, teeth will re- gain their natural whiteness. Plaque can be removed by abrasive substances or by enzymes that stick to proteins in the pelli- cle, thus facilitating the removal of stained plaque (28).

ii. Whitening toothpastes with abra- sive substances

The performance of these toothpastes is based on the size and hardness of the mol- ecules of the added abrasive substance, which are harder than the stain mole- cules. As a result, the stains are removed. Overall, the cleaning process is affected by the hardness, size, shape and concentra- tion of the particles and the pressure used in brushing the teeth. Usually such tooth- pastes are of medium (RDA - 60-100) or high (RDA> 100) abrasiveness. The most commonly used abrasive substances are silica dioxide, hydrated silica dioxide, cal- cium carbonate, calcium phosphate dihy- drate, calcium pyrophosphate, alumina oxide, perlite (70-75%silica dioxide) and sodium bicarbonate, which, together with the toothbrush bristles, remove the outer stained plaque, but do not change the color of the teeth. The problem with this is that the abrasive substances are effective only in places which can be reached by the toothbrush bristles. The effect is very slight on proximal surfaces and near the gum lines (5).

iii. Whitening toothpastes with chemi- cals

Surface stains can be reduced by adding various chemicals to toothpaste. Most of the stain molecules are included in the pellicle which contains protein. Therefore, enzymes such as protease and papaine create a whitening effect. This affects all locations where the toothpaste penetrates including proximal surfaces and near gum lines which are difficult to reach with a toothbrush. Sodium pyrophosphate, so- dium tripolyphosphate and other pyro- phosphates can bind with the enamel, dentin on tartar and absorb the stain mol- ecules, creating a whitening effect (5).

iv. Bleaching toothpastes

Bleaching toothpastes contain chemicals, most commonly - hydrogen peroxide or calcium peroxide (Calprox). When perox- ides touch the tooth surface or penetrate the tooth tissue, they break down the stain molecule, providing a bleaching ef- fect. Various bleaching systems - for home use or professional ones - also contain these substances. When adding peroxides to a toothpaste it should be noted that the concentration is small (usually 1% hydro- gen peroxide or 0.5-0.7% calcium perox- ide), and that there is a short exposure time, therefore there is a lack of evidence about whether such toothpastes can im- prove the internal tooth color. They cer- tainly bleach the pellicle on the tooth sur- face (18).

E. *Toothpastes with a specific purpose*

Some manufacturers claim to produce toothpastes to treat specific conditions, and such products do not belong to clas- sification groups mentioned previously.

Toothpastes containing olive oil, betaine and xylitol can stimulate salivary secre- tion when at rest, thus increasing the ba- sal rate of salivary secretion (8). In case of xerostomia, the mucous membrane is more sensitive and more vulnerable so one should avoid irritating toothpastes, such as those that contain strong essential oils and foaming substances, but antioxidants and enzymes such as lactoperoksidase, ly- sozyme, lactoferrin and glycozyloksidase are advisable. These ensure salivary func- tion (14).

The other example of toothpastes claim to solve specific problems, are antiviral prod- ucts. It has been proven that lariphan can mobilize the body's natural immune re- sponses, providing antiviral and immuno- modulatory activity. This also inhibits the penetration and growth of pathogenic bac- teria (24). Since the oral mucosa is a path- way for infection, it is likely that regular use of lariphan-containing toothpaste can prevent the formation and progression of inflammation caused by viruses and bac- teria. This could be an effective prevention and treatment of stomatitis (Particularly herpetic), gingivitis and periodontitis.

Conclusion

Dentifrices are used to remove of plaque biofilm.

• Dentifrices with triclosan and copoly- mer combination reduce dental plaque and symptoms of gingivitis, this support recommendation to use such dentifrices for prevention and treatment of periodon- tal diseases.

• Dentifrices are recognized as the best source of fluoride and can clean teeth most effectively in both deciduous and permanent series.

• Dentifrice can be used as analgesic sub- stance because some kind of dentifrices containing potassium salt maintain a high K+ extracellular level, thus preventing re- polarization of the nerve cell membrane and inhibiting the impulses transmission of without causing changes in the pulp.

• Dentifrice is used for whitening of teeth because surface stains can be reduced by adding various chemicals to dentifrice. Bleaching of discolored teeth is altogether a different process of whitening; wherein the dentin is treated with oxidizing agent which is given from outside enamel.

References

1. Marinho VCC, Higgins JPT, Sheiham A, Logan S. One topical fluoride (toothpastes, or mouthrinses, or gels, or varnishes) ver- sus another for preventing dental caries in children and adolescents. Cochrane Data- base Syst Rev, 2004; 1: 1-15.

2. llzeMaldupa, AndaBrinkmane, Inga Rendeniece, Anna Mihailova. Evidence based toothpaste classification, according to certain characteristics of their chemical composition. Stomatologija, Baltic Dent Maxillofac J, 2012; 14(1): 12-22.

3. Mickenautsch S, Yengopal V. Extent and quality of systematic review evidence related to minimum intervention in den- tistry: essential oils, powered tooth- brushes, triclosan, xylitol. Int Dent J, 2011; 61(4): 179-192.

4. Hannig C, Spitzmuller B, Lux HC, Al- tenburger M, Al-Ahmad A, Hannig M. Effi- cacy of enzymatic toothpastes for immobi- lisation of protective enzymes in the in situ pellicle. Arch Oral Biol, 2010; 55: 464-
469.

5. Charig AJ, Thong S, Flores F, Gupta S, Major E, Winston AE. Mechanism of ac- tion of desensitizing fluoride toothpaste delivering calcium and phosphate ingredi- ents in the treatment of dental hypersen-

sivity. Part II: comparison with a Profes- sional treatment for tooth hypersensitiv- ity. Compend Contin Educ Dent, 2009; 30(9):622-624, 626, 628.

6. Yuan P et al. Effects of Dentifrice Con- taining Hydroxyapatite on Dentinal Tu- bule Occlusion and Aqueous Hexavalent Chromium Cations Sorption: A Prelimi- nary Study. PLoS ONE, 2012; 7(12): e45283. doi:10.1371/journal.pone.0045283.

7. Ship JA, Mccutcheon JA, Spivakovsky S, Kerr AR. Safety and effectiveness of top- ical dry mouth products containing olive oil, betaine, and xylitol in reducing xero- stomia for polypharmacy-induced dry mouth. J Oral Rehabil, 2007; 34: 724-
732.

8. Martin us JV, Henk JB, Debbie J, Anje MS, Frank A, Henny CM. Efficacy of natu- ral antimicrobials in toothpaste formula- tions against oral biofilms in vitro. J Dent, 2011; 39: 218-224.

9. Ellwood RP, Cury JA. How much tooth- paste should a child under the age of 6 years use. Eu Arch Paediatr Dent, 2009; 10: 168-174.

10. Lima TJ, Ribeiro CC, Tenuta LM, Cury JA. Low-fluoride dentifrice and caries le- sion in children with different caries expe- rience: a randomized clinical trial. Caries Res, 2008; 42: 46-50.

11. New Zealand Guidelines Group. Guidelines for the use of fluorides. Wellington: New Zealand Ministry of Health; 2009. https://www.health.govt.nz/system/files/documents/publica- tions/guidelines-for-the-use-of-fluoride- nov09.pdf.

12. Rasines G. Fluoride toothpaste pre- vents caries in children and adolescents at fluoride concentrations of 1000 ppm and above. Evid Based Dent, 2010; 11: 6-7.

13. Scotland Dental Association: Reports on dental hygiene materials as per the guidelines of WHO.BDJ, 2013.

14. Susan J. Daniel, Shery A. Harfast, Re- becca S. Wilder Dental hygiene -Concepts, Cases and Competences, 2nd.Ed.

15. Wong MCM, Glenny AM, Tsang BWK, Worthington HV, Marinho VCC. Topical fluoride as a cause of dental fluorosis in children. Cochrane Database Syst Rev, 2010; 6: l-26.

16. Yin W. et al. Extrinsic stain removal eficacy of a new desensitizing dentifrice fluoride. Am J Dent, 2010; 23Sp Is: 36A- 40A.

17. Walsh T, Worthington HV, Glenny AM, Appelbe P, Marinho VC, Shi X. Fluoride toothpastes of different concentrations for preventing dental caries in children and adolescents. Cochrone Database Syst Rev, 2010; 1: CD007868. doi: 10.1002/14651858.CD007868.pub2.

18. Lin JT, Tsai CH, Yang LC, Chang YC. Clinical efficacy of phase I therapy com- bined with a triclocan/copolymer denti- frice on generalized chronic periodontitis. J Dent Sci, 2010; 5(4): 216-220.

19. Battino M. et al. In vitro antioxidant activities of anti-oxidant enriched. Free Radic Res 2005; 39: 343-350.

20. Lima TJ, Ribeiro CC, Tenuta LM, Cury JA. Low-fluoride dentifrice and caries le- sion in children with different caries expe- rience: a randomized clinical trial. Caries Res, 2008; 42: 46-50.

21. Wolfgang AH, Haase A, Hacklaender J, Gintner Z, Banoczy J, Gaengler P. Effect of pH of amine fluoride containing tooth- pastes on enamel remineralization in vitro. BMC Oral Health, 2007; 5: 3-8.

22. Mason S et al. A comparative clinical study investigating the efficacy of a denti- frice containing 8% strontium acetate and 1040 ppm fluoride in a silica base and a control dentifrice containing 450 ppm flu- oride in a silica base to provide immediate relief of dentin hypersensitivity. J Clin Dent, 2010; 21(Spec Iss): 42-48.

23. Baig A, He T, Buisson J, Sagel L, Suszcynsky-Meister E, White DJ. Extrin- sic whitening effects of sodium hexameta- phosphate- a review including a dentifrice with stabilized stannous fluoride. Com-pend Contin Educ Dent, 2005; 26: 47-53.

24. Nathoo S, Delgado E, Zhang YP, DeWizio W, Cummins D, Mateo LR. Com- paring the efficacy in providing instant re- lief of dentin hypersensitivity of a new toothpaste containing 8.0% arginine, cal- cium carbonate, and 1450ppm fluoride to a benchmark desensitizing toothpaste containing 2% potassium on and 1450ppm fluoride, and to a control tooth- paste with!450ppm fluoride: A three-day clinical study in New Jersey, USA. J Clin Dent, 2009; 20 (Spec Iss): 123-130.

25. Bailey D, Adams G, Marinho VCC, Tsao C, Hyslop A, Morgan M. Chlorhexi- dine interventions for the prevention of caries in adults (protocol). Cochrane Data- base Syst Rev, 2009; 3: l-5.

26. Wang Z, Sa Y, Sauro S, Chen H, Xing W, Ma X, et al. Effect of desensitising toothpastes on dentinal tubule occlusion: A dentine permeability measurement and SEM in vitro study. J Dent, 2010; 38: 400-
410.

27. Poulsen S, Errboe M, LescayMevil Y, Glenny AM. Potassium containing tooth- pastes for dentine hypersensitivity. Cochrane Database Syst Rev, 2008; 8: 1-
17.

28. Joiner A. Whitening tooth pastes: A re- view of the literature. J Dent, 2010; 38 (Suppl 2): e17-24.