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Stannous Fluoride Dentifrice with Sodium Hexametaphosphate: Review of Laboratory, Clinical and Practice-Based Data

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Abstract

Dentifrice was originally used to promote oral hygiene by cleaningteeth. However, with advances in product formulation, it has become a valuable vehicle for the delivery of agents offering health and cosmetic benefits. Stannous fluoride, introduced in 1955 in dentifrice, is one of the longest established of such agents. The well-known anti-caries efficacy of stannous fluoride is based on its impact on the tooth surfaces and on its antibacterial activity. More recently, the demand for tooth whitening products has increased and sodium hexametaphosphate has been shown to be helpful in whitening surface stains and in controlling calculus. A dentifrice formulation which combines the benefits of stannous fluoride with those of sodium hexametaphosphate is now available. A review of the evidence shows that in addition to effective anti-caries action, this formulation is effective in fighting plaque, gingivitis, and gingival bleeding while inhibiting calculus and extrinsic stain.

A practice-based evaluation including data from over 1,200 dental professionals and 1,000 patients demonstrates the product's benefits and excellent acceptability. Collectively, the research shows this stannous fluoride/sodium hexametaphosphate dentifrice provides multiple benefits to meet the oral health and cosmetic needs of patients.

Key Words: stannous fluoride, dentifrice, gingivitis, caries, sensitivity, calculus

Introduction

Patients today represent one of the most heterogeneous groups in history in terms of age, health status, oral hygiene habits and other factors.

While certain oral health conditions are more prevalent among specific patient groups, such as periodontal disease among diabetic patients,[1] many oral health conditions affect the broad population. According to U.S. surveys, virtually all adult patients have had dental caries, more than half experience gingivitis, and roughly one in three suffer from dental sensitivity.[2-4] Fortunately, home care products are available to help prevent and treat many common oral health conditions in conjunction with routine professional care.

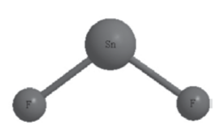
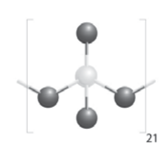
Stannous fluoride	Sodium hexametaphosphate
	
• Antibacterial activity against species associated with plaque, gingivitis, cavities and malodor • Reduces plaque • Reduces gingival inflammation and bleeding • Protects against hypersensitivity • Remineralizes enamel and protects against demineralization	• Inhibits calculus formation • Protects against new stain formation • Removes extrinsic stain

Figure 1. Benefits of stannous fluoride and sodium hexametaphosphate

Dentifrice is one important example. Many years ago, the benefits of dentifrice were limited to cleaning and the prevention of tooth decay. It was common for professionals to tell patients to "use any dentifrice with fluoride and the ADA Seal." However, formulators today can design dentifrices to provide numerous other benefits, both for health and cosmetic purposes.

In 2005, a stannous fluoride sodium hexametaphosphate (SFSH) formula* was introduced offering protection against a broad range of health and cosmetic conditions commonly experienced by patients.[5] The present report reviews the laboratory, clinical and practice-based assessments evaluating the efficacy of this dentifrice formulation.

Stabilized stannous fluoride/sodium hexametaphosphate formulation

The SFSH formula combines the therapeutic benefits of 0.454% stabilized stannous fluoride with the calculus and stain-control characteristics of sodium hexametaphosphate in a low-water formulation dentifrice. Stannous fluoride, which unlike sodium fluoride can be used in combination with calcium-based abrasives, has been incorporated in dentifrices since the 1950s to provide protection against caries, pathogenic bacteria, gingivitis, hypersensitivity, and the development of plaque. There is considerable evidence for its efficacy as a therapeutic agent with a wide spectrum of beneficial properties.[6-12] However, its clinical usage was limited because of astringent taste and in some patients its use resulted in extrinsic staining of the teeth. Stannous fluoride was also somewhat unstable in aqueous solution. The latter problem was resolved with the introduction of stabilized stannous fluoride in the 1990s which rendered more available stannous fluoride and resulted in a renewed interest in the wide range of benefits offered by stannous fluoride in dentifrices.[6]

Sodium hexametaphosphate was first introduced in a dentifrice in 2000.[15] It is a chemical whitening agent in the same class as pyrophosphate, which has long been used to inhibit calculus, but the molecule is about 10 times longer than that of pyrophosphate. Sodium hexametaphosphate therefore provides better coverage and retention on the tooth surface, thus increasing its ability to inhibit both calculus and stain formation on the enamel surface.[14] Stability of the dentifrice can be an issue with the inclusion of polyphosphates if ingredients are not properly balanced. Like other polyphosphates, sodium hexametaphosphate does not usually show good long-term stability in aqueous dentifrices. However the novel single-phase SFSH formula, which uses a low-water system in a silica-based formulation, significantly reduces the hydrolysis of sodium hexametaphosphate and helps to maintain effective levels of whitening activity.[5]

The resulting dentifrice has improved esthetic qualities over the original stannous fluoride formulation, and delivers a broad range of therapeutic and cosmetic benefits (Figure 1). The remainder of this paper provides a summary review of research on stannous fluoride, sodium hexametaphosphate and, especially, the unique SFSH formulation.

Antibacterial and Anti-inflammatory Action

Most of the oral health benefits of stannous fluoride result from its antibacterial efficacy, particularly against bacteria associated with dental caries, periodontal disease, and oral malodor. Laboratory and clinical studies have shown that stannous fluoride, unlike other fluorides, inhibits bacterial growth by a variety of mechanisms, including interference with metabolic pathways, thus reducing bacterial acid formation, and inhibition of bacte-

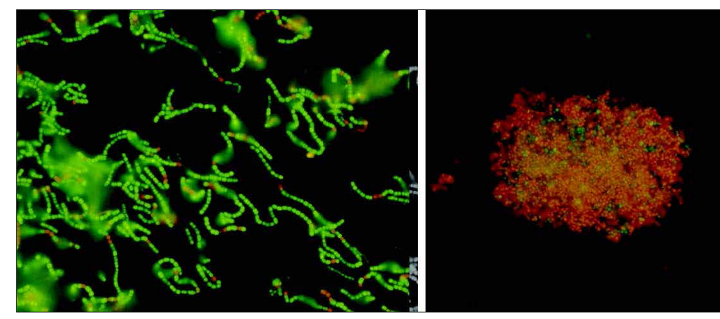


Figure 2. Bactericidal activity assessment 16 hours after exposure. Left; water control. Right; stannous fluoride/sodium hexametaphosphate dentifrice. Green-stained cells are live microbial cells; red-stained cells are dead cells (from Ramji et al[21]).

> Page 2B

< Page 1B

Reference	No. of Subjects	% SnF_2	Mode of Delivery	Treatment Frequency	Length of Trial	Plaque Reduction	% Reduction Gingivitis : Bleeding
Archila et al.[31]	186 adults	0.45	Dentifrice	Twice daily	6 months	ND	25.8%** : 27.4%**
Archila et al.[32]	38 adults resistant to NaF treatment	0.45	Dentifrice	Twice daily	12 weeks	ND	54%** : 55%**
Boyd et al.[28]	23 adolescent orthodontic	0.4	Brush-on gel	Twice daily	18 months	50% **	55%** : 50%**
Beiswanger et al.[9]	140 adults	0.45	Dentifrice	Twice daily	6 months	3% ns	19%* : 31% ns
Ciancio et al.[27]	28 adults	0.1	Mouth rinse	Twice daily	3 weeks	28% **	ND
Chitke et al.[26]	26 handicapped children	0.2	Spray	Twice daily	3 weeks	48% *	52%* : ND
Mallatt et al.[30]	128 adults	0.45	Dentifrice	Twice daily	6 months	8%**	17%** : 41%**
Mankodi et al.[23]	104 adults	0.45	Dentifrice	Twice daily	6 months	20%**	21%** : ND
Mankodi et al.[24]	130 adults	0.45	Dentifrice	Twice daily	6 months	7% **	22%** : 57%**
Perlich et al.[29]	154 adults	0.45	Dentifrice	Twice daily	6 months	3% ns	21%* : 33%*
Tinanoff et al.[25]	31 adults, partial denture	0.4	Brush-on	Twice daily	6 months	55% *[1]	48%* : 69%*
Williams et al.[10]	112 adults	0.45	Dentifrice	Twice daily	6 months	23% **	22%** : ND

All reductions are versus control except for Archila[32] and Chitke[26] which were relative to baseline values.
[1]Significant difference for abutment teeth.
* $p \leq 0.05$ ** $p \leq 0.01$ ND-no data ns-non significant

Table 1. Long-term clinical trials examining the effect of stabilized stannous fluoride on reduction of plaque, gingivitis and gingival bleeding.

rial cohesion and adhesion.[15-17] The Plaque Glycolysis and Regrowth Model (PGRM) is an in situ method that allows evaluation of a formulation's biological activity, based on its effects on plaque metabolism. Using a PGRM, White et al. found a statistically significant reduction in acidogenicity associated with the use of stannous fluoride dentifrice versus a standard sodium fluoride control dentifrice.[18,19] Using the same methodology, Liang et al. found that a stannous fluoride dentifrice, as compared to a control placebo, greatly reduced the amount of plaque acid and also inhibited plaque regrowth.[20]

Comparable results have been obtained in studies of the antibacterial action of this SFSH formula. Ramji et al. carried out a series of in vitro and in vivo studies of this new formulation.[21] In a Live/Dead assay21 they found that the new SFSH dentifrice had killed over 90% of the salivary bacteria 16 hours after a single exposure, thus showing strong and lasting antibacterial activity (Figure 2).

In a second study, using PGRM, the SFSH dentifrice produced statistically significant reductions in plaque acid production and plaque regrowth at 15 and 45 minutes after brushing versus a standard sodium fluoride control dentifrice.[21] Other research demonstrated the presence of soluble tin, which serves as a marker for the active stannous fluoride, at levels above the minimum concentration required for the inhibition of salivary bacterial activity.[21]

Another related value of stannous fluoride is its effect on inflammatory markers, independent of its action on bacteria. In vivo, antibacterial activity also helps reduce inflammation since the inflammatory response should diminish with reduced levels of pathogenic bacteria. A study was conducted with 16 healthy subjects to measure inhibition of several host and bacterial pro-inflammatory enzymes by stannous fluoride.[22] Following a one-week period of using a standard sodium fluoride paste and manu al brush, a baseline supragingival plaque sample was collected from subjects. Subjects then rinsed with a slurry of stannous fluoride/sodium hexametaphosphate dentifrice; plaque samples were taken immediately post-rinsing and 12 hours later. An analysis of the samples showed that stannous fluoride inhibited several pro-inflammatory enzymes, including mammalian matrix metalloproteinase subtypes and bacterial gingipain. These enzymes can break down proteins (e.g., collagen) and are involved in processes such as pocket formation. At the 12-hour analysis, enough stannous fluoride was retained to inhibit about 40% of most enzymes measured.

These studies demonstrate the sustained antibacterial and anti-inflammatory effects of this SFSH dentifrice, supporting its antiplaque and antigingivitis efficacy.

Anti-plaque and Anti-gingivitis Efficacy

Many studies have investigated the effects of stannous fluoride on gingivitis and plaque. These evaluations have involved a wide range of trial durations, subject populations and modes of application (Table 1).[23-34] The majority of these trials report significant reductions in plaque and gingivitis, supporting the agent's ability to improve gingival health when used twice daily.

In addition, long-term research has been conducted to evaluate stannous fluoride among special populations.[35] A 2-year study investigated the periodontitis prevention efficacy of a dual-phase stabilized 0.454% SFSH dentifrice compared to a positive control (sodium fluoride/triclosan dentifrice) in a population of over 330 subjects with medication-induced xerostomia. The study also evaluated the product's ability to remineralize root caries lesions. Results showed that twice daily use of stannous fluoride/sodium hexametaphosphate dentifrice demonstrated comparable benefits to the positive control, which was a sodium fluoride/triclosan dentifrice, in reducing periodontal pocket depth, attachment loss and bleeding on probing as well as remineralizing root caries.[35]

Recent studies have evaluated the antigingivitis efficacy of SFSH dentifrice.[24,30-32] One such six-month trial found statistically significant reductions of 22% in gingivitis, 57% less bleeding and 7% less plaque relative to a negative control.[24] In a second 6-month trial with 128 subjects, Mallatt et al. found a 17% reduction in gingivitis ($p \leq 0.001$), a 41% reduction in gingival bleeding ($p \leq 0.001$) and an 8% reduction in plaque ($p \leq 0.001$) with the SFSH dentifrice versus a negative control dentifrice.[30] The SFSH dentifrice also demonstrated significant reductions in gingivitis (26%) and gingival bleeding (27%) relative to a triclosan/copolymer control.[31] In a follow-up to this study, Archila et al. chose subjects who had used the triclosan/copolymer dentifrice twice a day but who had proved unresponsive to it, and still had high bleeding scores at the end of the six-month study period.[32] After three months use of the stannous fluoride/sodium hexametaphosphate dentifrice both gingivitis and bleeding had decreased significantly, by 54% and 55% respectively. These results showed that, even for those who have persistent problems with gingival disease, the SFSH dentifrice can offer significant health benefits when compared to other dentifrices.

In a three-phase study involving use of digital plaque imaging analysis (Figure 3), White et al. investigated the longer term efficacy of the SFSH formula in the control of plaque.36 In Phase 1, subjects brushed twice daily using a standard sodium fluoride dentifrice; in Phase 2 brushing frequency was reduced to once a day using the same dentifrice; in Phase 3 the daily brushing regimen was continued using the antimicrobial stannous fluoride/sodium hexametaphosphate dentifrice. Morning plaque coverage was 13% during Phase 1, increased to 18% in Phase 2, but decreased significantly in Phase 3 showing a 17% reduction as compared with the sodium fluoride dentifrice control. This supports the sustained antibacterial effects reported by Ramji et al.[21]

Results of multiple, independent clinical trials using the SFSH dentifrice mirror those investigating earlier stannous fluoride dentifrices; the recent formulation also shows benefits in the control of gingival disease where it is significantly more efficacious than sodium fluoride based dentifrices.

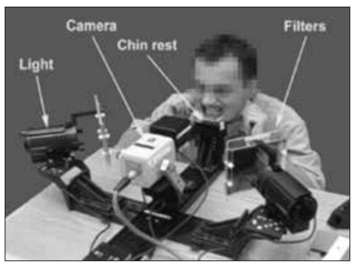


Figure 3. Plaque imaging system

Dentinal Hypersensitivity

Reports indicate that dentinal hypersensitivity affects more than 40 million people in the U.S. annually,[37] or up to 30% of adults at some time during their lifetime.[38] Hypersensitivity is characterized by a short, sharp pain arising from exposed dentin in response to a stimulus that cannot be ascribed to any other form of dental defect or pathology;[39] it arises from exposure of the dentinal tubuli to the stimulus. Unlike potassium nitrate, which alleviates sensitivity by acting on the nerve synapse, stannous fluoride reacts with enamel or dentin surfaces to produce solid complexes or insoluble precipitates which wholly or partially occlude the tubuli, as has been shown by means of scanning electron microscopy (Figure 4).[40]

This action is thought to produce the clinical efficacy of stannous fluoride in the prevention and control of dentinal hypersensitivity.[41-44] Schiff and his collaborators carried out two studies to assess the efficacy of the SFSH formula in reducing hypersensitivity on a sample population of 77.[45,46] The first used an eight-week randomized trial to compare the effects on dentinal sensitivity of twice-daily brushing with the stannous fluoride/sodium hexametaphosphate dentifrice and with a sodium fluoride-based, negative control dentifrice.[45] Outcomes were assessed at 4 and 8 weeks with tests of tactile sensitivity (Yeaple Probe Index) and thermal sensitivity (Schiff Air Index). On all assessments, the SFSH dentifrice produced a significant decrease in sensitivity ($p \leq 0.0001$) as compared to the control dentifrice. In the second study which used essentially the same procedures, results were similar, with the stannous fluoride/sodium hexametaphosphate group (n=45) producing significant reduction in sensitivity compared to the control (n=45) (Figure 5).[46] At 8 weeks, the SFSH showed improvements of 71% and 44% versus the negative control for tactile and thermal measurements, respectively.

These studies support that the SFSH dentifrice shares the antisensitivity characteristics of previous stannous fluoride formulations.

Anti-caries Effects

The anticaries effects of stannous fluoride have been recognized for over 50 years and in the 1960s, the stannous fluoride-containing dentifrice, Crest® with Fluoristan™, received a Seal of Acceptance by the ADA's Council on Dental Therapeutics. Fluoride, in various forms, is well-recognized for its ability to foster remineralization of partially demineralized tooth enamel using the calcium and phosphate present in saliva. In addition to these remineralization effects, stannous fluoride has been shown to react with enamel to form a tin fluorophosphate complex which coats and protects the surface of the enamel.[48,49] The antibacterial activity of stannous fluoride, which was discussed above, provides further protection by suppression of bacteria, particularly Streptococci mutans, which are one of the primary pathogens associated with dental caries.[50,51] The anti-caries benefits of stannous fluoride are therefore due both to physical chemistry and its bacteriological effects.

Before the introduction of this SFSH dentifrice, a large number of clinical trials had been carried out that demonstrated the efficacy of stannous fluoride in the control of dental caries.[52] More recently, Stookey et al. carried out a large-scale clinical trial with 955 subjects comparing the anticaries efficacy of a dual-phase early prototype SFSH dentifrice with a positive control standard sodium fluoride dentifrice, and also a high-dose (2800 ppm F) and a low-dose (500 ppm F) sodium fluoride formulation.[53] Visual-tactile examination was supplemented with a radiographic examination at baseline, after 12 months and at the end of the trial at 24 months. Both examiners found that there was significantly less caries in the SFSH (17% and 25%) and high dose (2800 ppm) sodium fluoride groups (13% and 23%) than in the positive control group treated with 1100 ppm fluoride. In an in situ study of mineralization-demineralization, Wefel et al. reported that a dual-phase stannous fluoride/sodium hexametaphosphate dentifrice produced anticaries activity which

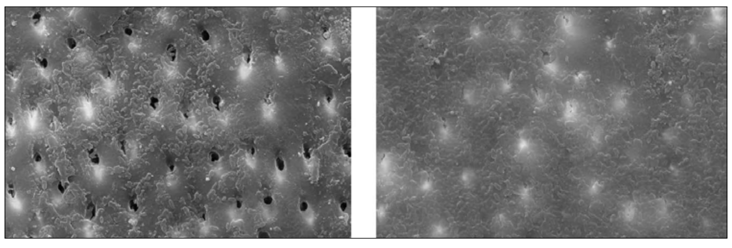


Figure 4. Left: Scanning electron microscopy images showing open tubuli after treatment with a sodium fluoride toothpaste (left) and closed tubuli after treatment with a SFSH dentifrice (right). From Baig and He.[5]

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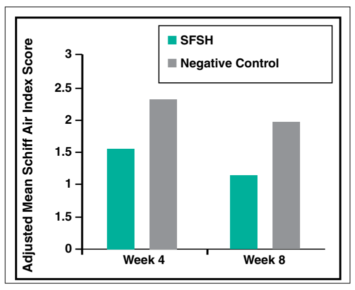

Figure 5 – Thermal sensitivity scores for the SFSH dentifrice and negative control (lower scores indicate less sensitivity) [46]

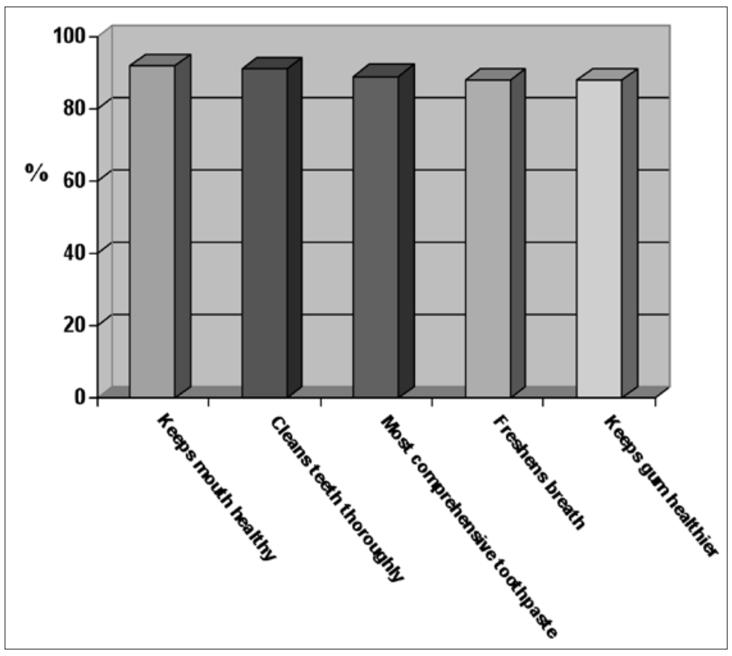

Figure 6 – Results from patient surveys; Percent of patients rating SFSH product "Excellent/Very Good/Good".

was as good as that of positive controls and concluded that the addition of sodium hexametaphosphate does not interfere with the normal activity of stannous fluoride.[54]

A series of in vitro studies evaluating the anticaries potential of the SFSH formulation have been reported in one publication by Pfarrer and colleagues.[55] In a study of fluoride uptake into demineralized enamel, it exhibited uptake comparable to a clinically proven stannous fluoride and silica dentifrice.[55] In a second lesion progression pH-cycling experiment the stannous fluoride/sodium hexametaphosphate dentifrice provided almost complete protection against lesion initiation and progression; it was comparable to conventional clinically proven dentifrices.[55]

These studies indicate that this SFSH dentifrice is as effective as clinically proven fluoride dentifrices both in its mode of action and in its clinical effects.

Anticalculus Effects

Dental calculus results from the mineralization of bacterial plaque formed on the surfaces of teeth. Agents that inhibit crystal growth, particularly condensed phosphates, have been found to be very useful in the prevention of calculus development. In this class of phosphates, sodium hexametaphosphate has been shown to be particularly effective. In vitro studies by White et al. have shown significant reductions in hydroxyapatite crystal growth and mineralization of plaque in the presence of sodium hexametaphosphate either in aqueous solution or in a dentifrice.[56] The effects were significantly greater than for a conventional anti-tartar dentifrice containing pyrophosphate. This finding has been supported by four 6-month clinical trials in which sodium hexametaphosphate produced significant reductions in calculus formation – when combined with sodium fluoride or stannous fluoride – as compared to a regular sodium fluoride dentifrice or a triclosan/copolymer dentifrice.[57-60] A total of 866 subjects participated in the four 6-month clinical trials. Efficacy was assessed using a standard clinical method (Volpe-Manhold Index) that measures supragingival calculus coverage on the lingual surfaces of the 6 anterior teeth. In the 2 studies evaluating SFSH formulations, calculus reductions of 55% and 56% were seen versus the respective controls at 6 months.[59,60]

Whitening Effects

There is an increasing demand for tooth whitening products and also for oral care products that sustain whitening effects. Peroxide is a successful bleaching agent when delivered via whitening strips or in tray-based systems, but it is not particularly effective in dentifrices because of the brief contact time with the tooth surface.[61] Pyrophosphates, on the other hand, help maintain whitening and control staining because they have a strong affinity for the minerals in teeth. Sodium hexametaphosphate has been shown to have important effects on the chemical mechanisms of chromogen adsorption and desorption.[62-63] It appears that the polymer chains interact with pellicle films to lift stain material out of the pellicle and to prevent the adsorption of new chromogens. Gerlach et al. reported a 29% reduction in composite stain relative to a negative control following 6 weeks use of a sodium fluoride dentifrice containing 7% sodium hexametaphosphate.[64] Clinical studies providing evidence for the efficacy of sodium hexametaphosphate in the control of extrinsic staining have been reviewed by Baig et al.[65]

A number of recent clinical trials have assessed the extrinsic stain removal efficacy of the SFSH dentifrice. In their 6-month study of anti-calculus effects, Schiff et al.[59] also assessed extrinsic stain, using the Lobene Stain Index on the facial surfaces of the 12 anterior teeth; at neither 3 nor 6 months did subjects in the SFSH group show signs of developing any such stain. Four recent clinical trials, which were summarized in two publications, have used similar methodologies to compare the extrinsic stain removal efficacy of the SFSH dentifrice with that of a positive control whitening dentifrice.[66,67] All 4 were randomized, double-blind studies in which efficacy was measured using a modified Lobene Stain Index. Two studies assessed whitening at baseline and 2 weeks;67 the other 2 studies measured stain at baseline, 3 and 6 weeks.66 In all cases, there was highly significant stain removal in the experimental groups and also in the positive control groups. There were no significant differences in the effects of the SFSH and positive control dentifrices.

In reviewing these data, it appears that combining sodium hexametaphosphate with stannous fluoride in the SFSH formulation removes and inhibits extrinsic stain formation and that the SFSH dentifrice is as effective as positive control whitening dentifrices.

Practice-Based Evaluation

The efficacy and safety of dentifrice with stannous fluoride or a combination of stannous fluoride and sodium hexametaphosphate is supported by an extensive body of evidence. However, its success ultimately depends on its acceptability to users when used at home by consumers as part of their own personal oral hygiene routine. In order to assess the acceptability of the SFSH dentifrice, a practice-based assessment was undertaken involving dental professionals and their patients.[68] Dentists and hygienists across the USA participated in the study, and samples of the SFSH formulation were offered to participating professionals to provide a supply to a small group of their patients for 3-4 months use, until their next visit. Patients' oral health was assessed at the beginning and end of the trial by the dental professional using a questionnaire (not clinical indices). Conditions assessed included gingivitis, gingival bleeding, inflammation, calculus, extrinsic staining and sensitivity. Professionals submitted a survey report and patients completed a questionnaire at the end of the study.

In total, 1267 completed surveys were returned by dentists and dental hygienists. Approximately 75% of the evaluations were based on 3-4 months use and the remainder of subjects had used the product for up to 6 months. Responses analyzed were those in which dentists or hygienists provided both pre- and post-trial oral health assessments and gave answers to questions. Sixty-eight percent of all these responses reported improvement in their patients' oral health, including improvements in gingival bleeding and inflammation and reduction in calculus formation. Reductions in sensitivity were reported by 61% of professionals and in staining by 57%. Eighty percent reported they would recommend the SFSH dentifrice; this rose to 91% among those professionals who observed improvements.

A total of 1078 questionnaires were returned by patients. Of these, 88% reported positive assessments of the SFSH dentifrice (Excellent/Very Good/Good) and two-thirds of all patients stated that they intended to continue to use the product; this percentage rose to 77% when patients reported noticeable improvements in their oral health. In terms of rating specific effects, roughly 9 out of 10 patients rated the product positively for "keeping mouth healthy", "cleaning teeth thoroughly", being a "comprehensive toothpaste", "making gums healthier" and "freshening breath" (Figure 6). Eighty-three percent rated it positively for reducing surface stains and 77% for reducing gingival bleeding.

It is important to differentiate practice-based evaluations from randomized, controlled clinical studies. For example, clinical trials typically involve calibrated examiners who use standardized indices to assess the status of a specific disease or condition. Often the examiner and subject are blind to treatment. In this practice-based assessment, practicing professionals and their patients assessed oral conditions using a questionnaire. Calibration was not done across offices and the product identity was known. This type of evaluation is similar to the assess ments practicing professionals do on a routine basis. They recommend a home care product, and then use their experience and clinical judgment to determine the effect it has on the patient's oral health. This large, practice based assessment with the SFSH dentifrice complements findings of the controlled clinical trials. The major outcome is that it provides evidence of excellent professional acceptance and an equal level of acceptance among patients, expressed as an intention to continue using the SFSH dentifrice.

Conclusions

Extensive laboratory and clinical research add to the body of research supporting the value of stannous fluoride as a multi-benefit dentifrice ingredient. Stannous fluoride reduces bacterial growth, bacterial activity, and inflammatory markers as well as protects against plaque, gingivitis and gingival bleeding, hypersensitivity and caries. Research also suggests the effectiveness of sodium hexametaphosphate in the control of calculus and extrinsic staining. Seventeen published clinical and laboratory papers demonstrate the efficacy of these dentifrice ingredients when they are combined in a dentifrice formulation, which is therefore able to deliver a wide combination of health and cosmetic benefits.[21, 24, 30-32, 35, 36, 45- 47, 53-55, 59, 60, 66, 67] Results from a large practice-based assessment involving over 1,200 dental professionals and over 1,000 patients further support the product is widely acceptable and beneficial for improving oral health.[68]

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References

1. Genco RJ. The three-way street. Sci Am. 2006;Spec Iss:18-22.
2. U.S. Department of Health and Human Services. Oral Health U.S. 2002. Available at: http://drc.hhs.gov/report/pdfs/section3-diseases.pdf Accessed Dec 5, 2007.
3. Surveillance for dental cares, tooth retention, edentulism, and enamel fluorosis – United States, 1998-1994 and 1999-2002. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5403a1.htm. Accessed Dec 11, 2007.
4. Addy M. Dentin hypersensitivity: new perspectives on an old problem. Int Dent J. 2002;52:367-375.
5. Baig A, He T. A novel dentifrice technology for advanced oral health protection: A review of technical and clinical data. Comp Contin Educ Dent. 2005;26:4-11.
6. White DJ. A "return" to stannous fluoride dentifrices. J Clin Dent. 1995;6(spec no):29-36.
7. Tinanoff N. Review of the antimicrobial action of stannous fluoride. J Clin Dent. 1990;2:22-27.
8. Tinanoff N. Progress regarding the use of stannous fluoride in clinical dentistry. J Clin Dent. 1995;6(spec no):37-40.
9. Beiswanger BB, Doyle PM, Jackson RD, et al. The clinical effect of dentifrices containing stabilized stannous fluoride on plaque formation and gingivitis—a six-month study with ad libitum brushing. J Clin Dent. 1995;6(spec no):46-53.
10. Williams C, McBride S, Bolden TE, et al. Clinical efficacy of an optimized stannous fluoride dentifrice, part 3: a 6- month plaque/gingivitis clinical study, southeast USA. Compend Contin Educ Dent. 1997;18(spec iss):16-20.
11. Gerlach RW, Hyde JD, Poore CL, et al. Breath effects of three marketed dentifrices: a comparative study evaluating single and cumulative use. J Clin Dent. 1998;9:83-88.
12. Miller S, Truong T, Heu R, et al. Recent advances in stannous fluoride technology: antibacterial efficacy and mechanism of action towards hypersensitivity. Int Dent J. 1994;44 (1 suppl 1):83-98.

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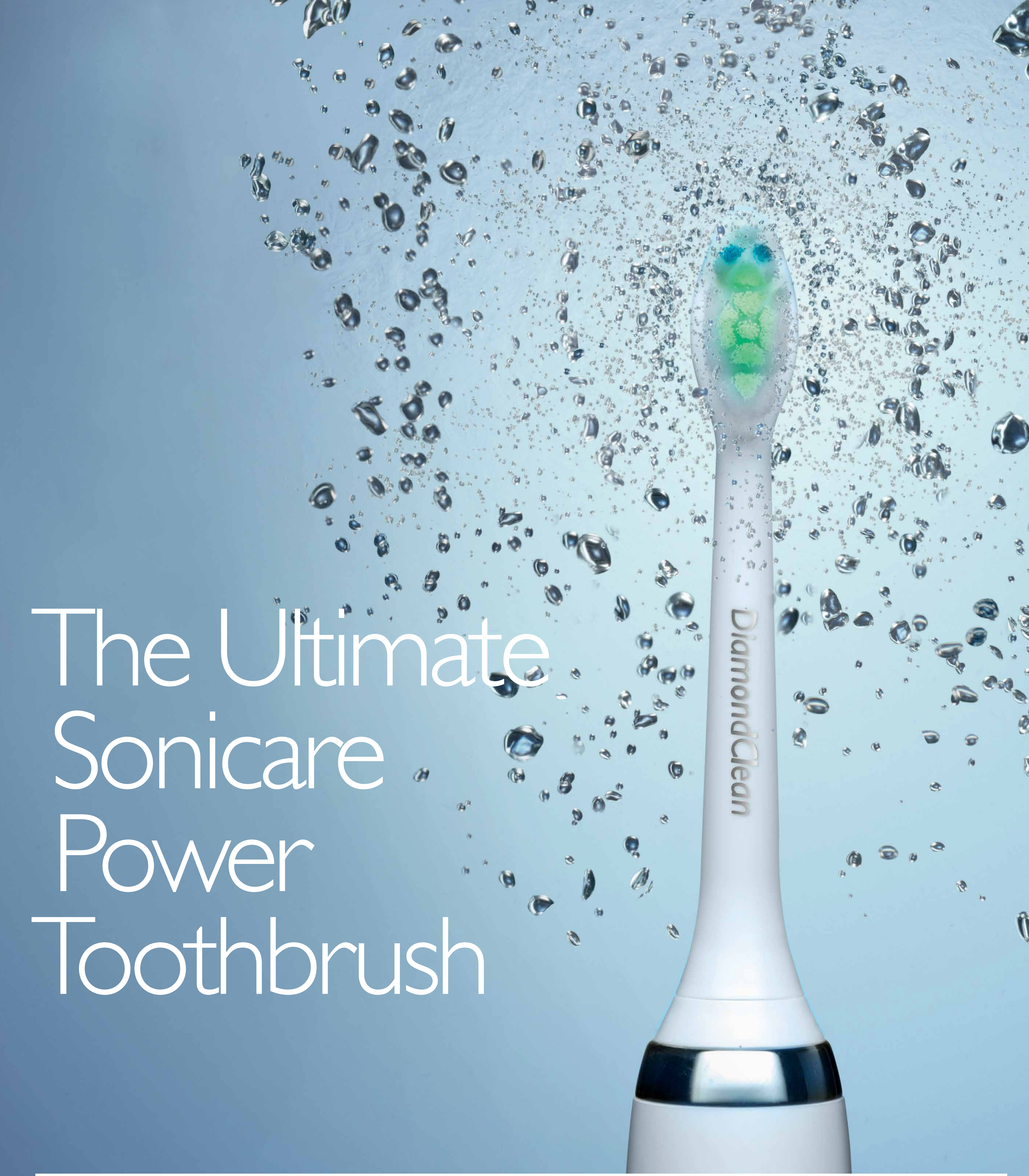

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1. Putt M, Milleman J, DeLaurenti M, Schmitt P. Plaque removal efficacy of two novel Philips Sonicare DiamondClean brush heads. Data on file, 2010. 2. Milleman J, Putt M, DeLaurenti M, Souza S, Jenkins W. Comparison of gingivitis reduction and plaque removal by Sonicare DiamondClean and a manual toothbrush. Data on file, 2011. 3. Colgan P, DeLaurenti M, Johnson M, Jenkins W, Strate J. Evaluation of stain removal by Philips Sonicare DiamondClean power toothbrush and manual toothbrushes. Data on file, 2010.

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Extrinsic tooth discoloration, an updated review

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Abstract
The appearance of the dentition is of concern to a large number of people seeking dental treatment and the color of the teeth is of particular cosmetic importance. Discolored teeth are seen frequently in the dental office and present a major challenge to dentists. The causes of tooth discoloration are varied and complex. Basically, there are two types of tooth discolorations: those caused by extrinsic factors and those caused by intrinsic congenital or systemic influence. The majority of tooth discolorations are extrinsic in nature and appear as brown integuments. Dental treatment of tooth discoloration involves identifying the etiology and implementing therapy. An overview of the extrinsic etiologies and the clinical appearance of tooth discoloration are discussed in this review.

Key-words: Discoloration, stains, etiology, whitening, chromogenic product.

Introduction

Ever since the ancient times, mankind has been questing for beauty through the perfection of every detail. Ancient Romans, for example, used urine and goat milk in an attempt to whiten their teeth. There has been a recent increase in interest in the treatment of tooth staining and discoloration as shown by the large number of tooth whitening agents appearing on the market.[1]

Teeth discolorations are associated with many clinical and esthetical challenges. They can have an impact on a person's self-image and self-confidence in today's society, where most people place tooth color high. The correct diagnosis of the cause of discoloration is important as it has a profound effect on treatment outcomes.

Normal enamel is colorless and translucent, and the color of the dentin is mainly responsible for the color of the tooth. The dentin influences more on the tooth color where it consists of thick layers and where the enamel layer is thin (cervical margins). A variety of colors can typically be seen in a tooth and from the gingival margin to the incisal edge of the tooth a gradation of the color occurs. Any changes of tooth structure is likely to cause an alteration in outward appearance of the tooth caused by changes of light transmitting and reflecting properties[2]: Some discolorations are located on the outer surface of the tooth structure, others are caused by stain taken up by the enamel or dentin, and some occur during tooth development and result in an alteration of the light transmitting properties of the tooth structures. Tooth discolorations are caused by multiple factors: medications, genetic defects, diseases, trauma, caries and normal aging processes are some examples. It is important to understand what staining is in order to be able to prevent it. There are two types of tooth discoloration: extrinsic which affects teeth from the outside and intrinsic which affects the teeth from the inside.

Extrinsic discoloration lies on the tooth surface or in the acquired pellicle. The majority of tooth discolorations are extrinsic in nature and appear as brown integuments. Extrinsic staining of a single tooth is unusual. The distribution is usually generalized. The stains are usually found on surfaces with poor tooth brush accessibility. Smoking, tea or coffee consumption and increasing age are promoting factors and such discolorations are frequently seen in connection with oral use of antibacterial plaque-inhibiting mouthrinses. Chemical alteration of the acquired pellicle appears to be the major reason for these brown integuments.[3]

The causes of extrinsic staining can be divided into two categories; those compounds which are incorporated into the pellicle and produce a stain as a result of their basic color 2 and those which lead to staining caused by chemical interaction at the tooth surface.[4]

Direct staining has a multi-factorial etiology with chromogens derived from dietary sources or substances habitually placed in the mouth. These organic chromogens are taken up by the pellicle and the colour imparted is determined by the natural colour of the chromogen. The origin of the stain may be metallic or non-metallic.[5 6]

The aim of this review is to systematically search the literature for data concerning extrinsic tooth discoloration etiologies in order to establish the right treatment plan.

1 - Tobacco

For ages, tobacco has been popular and its use is significantly increasing in spite of alarming health hazards.[7]

Tobacco smoking and chewing (chewing of betel morsel: piper betel, Pan) are known to cause staining.[8] Smoking leads to not only tobacco and nicotine stains on teeth (yellowed teeth) but it also leads to gum disease and oral cancer.[9] There are all sorts of chemicals in cigarettes, including tobacco, nicotine and tar that could harm gum tissue cells, weakening it in the face of periodontal diseases and infections. This is true of cigarettes, pipes, chewing tobacco, waterpipe and cigars to varying degrees, all will cause bad breath, crippled teeth and ugly brownish-yellowish stains. Tobacco is rich with nicotine[10,11] which is named after the tobacco plant Nicotiana tabacum.[7] It is an inherently colorless substance that turns yellow when put in contact with oxygen. When cigarette smoke is inhaled, the insides of the mouth is coating not only with tar from the tobacco smoke but with nicotine. Nicotine penetrates the nooks and crannies of the teeth leading to teeth stains. Tobacco smoke contains carbon monoxide, thiocyanate, herbicide, fungicide and pesticide residues, tars, and many other substances which promote diseases and impair the body's defense mechanism and functions. Toxic substances in the tobacco smoke affect virtually every viable cell type.[7]
A quantitative synthesis of the limited human data from 117 adults from Lebanon, Jordan, Kuwait, and India indicates that daily waterpipe use produces nicotine absorption of a magnitude similar to that of daily use of cigarettes. This equivalence with cigarette use of about 10 cigarettes/day.[10]
Smoking cessation support interventions with an added stain removal or tooth whitening effect may increase motivation to quit smoking. Oral health professionals are well placed to provide smoking cessation advice and support to patients. A study evaluated the effect of a gum used in a smoking cessation program administered in a dental setting, on extrinsic stain and tooth shade among smokers. At week 6, the gum-group experienced a reduction in mean stain scores whilst the tablet-group experienced an increase. The change in mean tooth shade scores was statistically significantly greater in the gum-group than in the tablet group at 2, 6 and 12 weeks with greater lightening in the gum-group at each examination period.[12]

2 - Dark Drinks

From black coffee to red wine, food and beverages can cause the pearly whites to become yellows.The foods that are most likely to stain or discolor teeth are:

a - Black Coffee

Although melanoidins from coffee possesses antioxidant capacity,[13] deposition of tannins found in tea, coffee, and other beverages cause brown stains. The darker the coffee, the more it stains the teeth. Adding milk or cream will actually help. A study done by JZ Bazzi showed that toothbrushing resulted in a significantly reduced color change only for cigarette smoke–stained specimens and not for coffee stained teeth, which means that coffee stains teeth more indelibly than tobacco.[14]

According to Pirolo, the exposure to coffee after bleaching causes less color changes than the exposure to a cola-based soft drink regardless of the time after bleaching.[15]

A study evaluated the colour stability of three laminate veneer materials with tea, coffee and cigarette. It was found that cigarette smoke was the most staining agent.[16]

The aim of an in vitro study done by Mutlu-Sagesen et al was to compare the color stability of commercially available denture teeth materials.The filtered coffee solution was found to be more chromogenic than the tea, and cola staining solutions.[17]

b - Tea

Tea, the commonly consumed beverage, is gaining increased attention in promoting overall health. In specific, green tea is considered a healthful beverage due to the biological activity of its polyphenols.[18,19] There are three main varieties of tea - green, black, and oolong, all derived from the leaves of the C. sinensis plant. The difference between the various teas lies in their processing. Green tea is prepared from unfermented leaves, the oolong tea leaves are partially fermented and black tea is fully fermented.[20]

Lee R et al have shown that the addition of milk to tea significantly reduces the tea's ability to stain teeth. Casein was determined to be the component of milk that is responsible for preventing tea-induced staining of teeth to a similar order of magnitude that can be obtained by vital bleaching treatments.[21]

Bovine teeth were immersed for one week in a solution of tea, coffee or red fruits respectively. Tests showed that diode laser was effective only at bleaching teeth stained with coffee meanwhile the KTP laser was efficient at bleaching teeth with coffee, tea and red fruits stain. This study suggests that a relation between the laser wavelength and the type of staining on the dental enamel and the efficacy of the whitening treatment exists.[22]

In a work done by Young N et al of the basic interactions between whitening agents and tea stain molecules, it was shown that the reaction rates between chromogens in the tea solution and hydrogen peroxide can be accelerated significantly using ferrous gluconate activator and blue light irradiation.[23]

As for all colored beverages, in order to minimize the staining effect of tea, it can be drunk through a straw.

c - Red Wine

Red wine is packed with polyphenols[24] that help prevent periodontal diseases that damage the gums and bone around teeth.[25, 26, 18] Nevertheless red wine causes tooth staining. In addition, the alcohol content is very acidic and wears away tooth enamel.

A research aimed to investigate bleached enamel susceptibility to coffee and red-wine staining at different time periods after bleaching. No differences were observed between the exposure times of 30 and 150 min after bleaching for both beverages ($p > 0.05$). Although coffee did not stain the surface, red wine significantly darkened previously bleached enamel.[27]

Attia et al have quantified the change in color of human and bovine teeth exposed to a coffee solution during a 16% carbamide peroxide (16% CP) home application bleaching treatment using photoreflectance analysis. When the teeth were exposed to a coffee solution during home bleaching treatment, the whitening effect was observed to be less stable ($P < 0.05$).

Bovine and human enamel substrates behaved similarly in terms of staining and bleaching effects, although they presented inherent differences in color.[28]

A study has examined the surface staining mechanism of a photopolymerized composite by coffee, oolong tea, and red wine. Dental composite was subjected to an experimental 24-hour staining cycle: 17-hour immersion in artificial saliva solution containing 0.5% mucin followed by 7-hour immersion in coffee, tea, or wine. Wine caused the most severe staining, followed by tea and coffee. Chlorhexidine increased the staining effect of tea and coffee when compared to the control specimens. Common drinks stained the dental composite, but each by a specific mechanism that depended on external conditions such as the presence of chlorhexidine.[29]

Cortes et al have evaluated the influence of coffee and red wine staining on tooth color during and after bleaching. Blocks obtained from human molars were divided into 11 groups in accordance with the bleaching treatment-peroxide carbamide 10%, 15% or 20%- and in accordance with the stain therapy-coffee, wine or without staining (control). During bleaching, remineralization of the enamel with artificial saliva and the subsequent bleaching were effective in preventing enamel staining. After the whitening procedures, both stain therapies-coffee

> Page 8B

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References: 1. Jeandot J *et al.* Clinc (French) 2007; 28: 379–384. 2. Nagata T *et al.* J Clin Periodontol 1994; 21(3): 217–221. 3. GSK data on file. DOF Z2860473. 4. Leight RS *et al.* J Clin Dent 2008 19(4) 147-153. 5. Schemehorn BR *et al.* J Clin Dent 2011 22(1) 11-18. 6. Shellis RP *et al.* J Dent 2005 33(4) 313-324. 7. GSK data on file. DOF Z2860415. 8. GSK data on file. DOF Z2860435.

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< Page 6B

and wine-caused enamel color changes; however, the wine led to greater staining than did coffee.[30]

d - Cola Drinks

Dark-colored colas not only stain teeth, but also erode tooth enamel and cause tooth decay,[31, 32, 33] although a new article found no significant differences in the frequency of the consumption of foods and beverages and the presence of dental erosion.[34]

Other articles found greater enamel dissolution occurring in flavored and energy (sports) drinks than in cola drinks.[35, 36]

The influence of coffee, tea, cola, and red wine staining on the color of teeth after home bleaching has been evaluated. A total of 45 samples were obtained from 45 sound maxillary central incisors. The samples were immersed in four staining solutions (coffee, tea, cola, and red wine) or artificial saliva. Following 15 min and 6 h of immersion on the first day and next day of all the staining solutions, the lowest ΔE values were observed with coffee staining versus artificial saliva (control group), for all time intervals evaluated after whitening. There were statistically significant differences between the red wine, cola, and tea solutions.[37]

A study assessed the influence of surface sealant on the color stability of composite resins.

Red wine resulted in the highest level of discoloration. Intermediate values were found for orange juice, and the cola soft drink.[38]

e - Cranberry Juice

Some drinks that may be relatively good for health may not be so good for teeth in terms of staining them. Cranberry juice, grape juice and other dark-colored fruit juices are very good at staining teeth because they contain pigments--and lots of them--that can yellow teeth, probably the same way they stain composite resin.[39]

Cranberry Juice contains potential anticaries agents (high-molecular-weight polyphenols) that inhibit the production of organic acids and the formation of biofilms by cariogenic bacteria.

The polyphenols of cranberries interfere with various activities (including formation of biofilm and adhesion) of Porphyromonas gingivalis, the main etiologic agent in chronic periodontitis.[40, 41]

In order to avoid these stains, straws should be used and mouthwash followed by tooth brushing should be done.

f - Soy Sauce

Soy sauce is a condiment made from a fermented paste of boiled soybeans, roasted grain, brine, and Aspergillus oryzae or Aspergillus sojae molds.[42]

Iron-fortified foods can help prevent iron deficiency so can iron-fortified soy sauce due to the relatively high iron absorption from soy sauce.[43, 44] But soy sauce sticks to teeth, and the deep-colored pigment can cause very bad stains. In a study done by Chan KC, the discoloration of enamel caused by food substances was found to be superficial and ingressive for dentin and cementum. Discoloration of cementum exceeded that of dentin, and dentin stained more than enamel. Coffee and soy sauce stained the calcified dental tissues more than the cola beverage and tea. The longer the staining time, the deeper was the discoloration.[45]

g - Balsamic Vinegar

Balsamic vinegar is made from grapes and generally consumed in the Mediterranean region.

Oxidized low-density lipoprotein (LDL) is believed to contribute to atherosclerosis. Studies results showed that balsamic vinegar contained abundant polyphenols and inhibited LDL oxidation.[46, 47] Thus, balsamic vinegar reduces lipotoxicity, and it has an anti-diabetic effect.[48]

In spite of these health benefits, Balsamic vinegar is deeply pigmented causing teeth discoloration.

h - Tomato Sauce

Lycopene is the pigment principally responsible for the characteristic deep-red color of ripe tomato fruits and tomato products.

Lycopene is a micronutrient with important health benefits, because it contains natural antioxidant compounds like phenolics hydroxytyrosol and appears to provide protection against a broad range of epithelial cancers.[49, 50]

But the tomato sauce is highly acidic and it attaches to the teeth and causes unsightly stains.

i - Blueberries

Berries are a rich source of a wide variety of non-nutritive, nutritive, and bioactive compounds such as flavonoids, phenolics, anthocyanins, phenolic acids, stilbenes, and tannins, as well as nutritive compounds such as sugars, essential oils, carotenoids, vitamins, and minerals. Bioactive compounds from berries have potent antioxidant, anticancer, antimutagenic, antimicrobial, anti-inflammatory, and antineurodegenerative properties, both in vitro and in vivo.[51]

Wild blueberries are rich in polyphenols and have several potential health benefits.[52] For example Blueberry extracts may reverse the declines of cognitive and behavioral function in the ageing process.[53] Anthocyanin- and proanthocyanidin-rich botanical extracts, present in berries, may alleviate neurodegeneration in Parkinson's disease.[54] Polyphenols found in the wild blueberries help in reducing the expression of pro-inflammatory genes in vitro[55] and current evidences are promising concerning the role of berry (poly) phenols to support cardiovascular health.[56]

Even if the deep berry blue color can cause deep staining, aren't all the benefits cited above worth staining teeth?

3 - Betel leaf: India,Pakistan

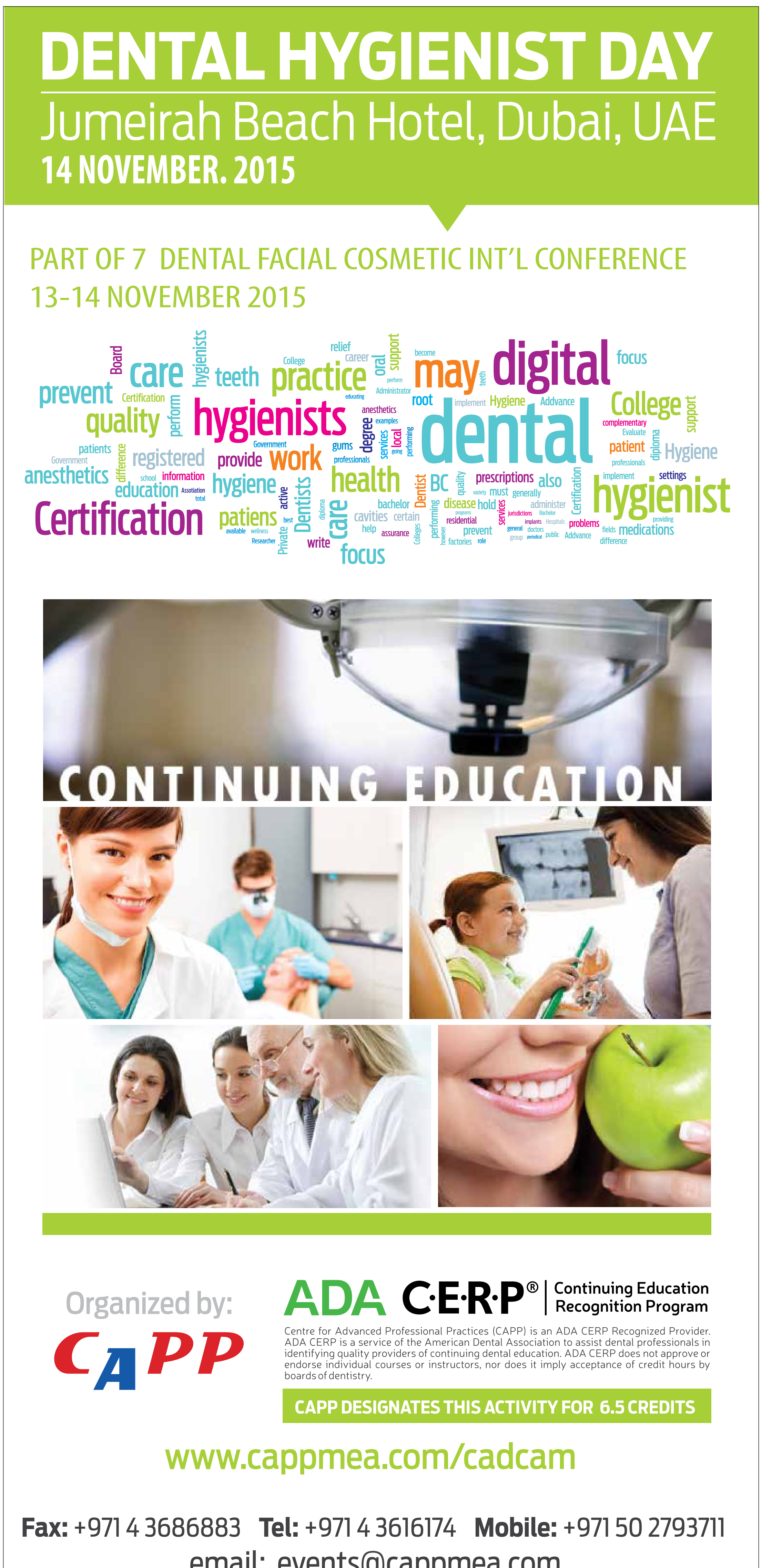
The betel (Piper betle or Paan) is the leaf of a vine belonging to the Piperaceae family, which includes pepper and kava. Explored for their unique medicinal properties, the leaves of Piper betel, an evergreen perennial vine, are a reservoir of phenolics with antimutagenic, antitumor and antioxidant activities.[57] It is a compound of natural substances chewed for its psychostimulating effects. Studies showed that oral feeding of betel leaf extract (BLE) significantly inhibited the growth of human prostate.[58, 59] It is believed that chewing betel quid could reduce stress, strengthen teeth and maintain oral hygiene.[60]

Approximately 200 million persons chew betel regularly throughout the western Pacific basin and south Asia. There is copious production of a blood-red saliva that can stain oral structures. After years of chewing, the teeth may become red-brown to nearly black.[61]

4 - Liquorice

It is a uniquely tasting herb derived from Glycyrrhiza glabra, and has been used in medicine

> Page 9B



Conservative Care and Treatment of TMJ Dysfunction in Dental Patients

By Shivani Sarsthi, Physical Therapist (TMJ Specialist)

Each year, the number of reported cases of TMJ dysfunction patients increases. Whether the cause is from stress, trauma to the jaw, post-dental procedures, or other factors, the number of TMJ sufferers is growing. TMJ dysfunction is defined as a term covering pain and dysfunction of the muscles of mastication and the temporomandibular joints.

The symptomatic picture of a TMJ patient does vary significantly, but often includes: muscle, joint, and facial pain, difficulty with chewing, joint sounds, headaches and tinnitus. Recent studies show that more females than males suffer from TMJ symptoms, most of which, are in their childbearing years.
The conventional methods used to treat TMJ dysfunction include: Botox to relax specific muscle groups (masseters), orthodontics (braces, retainers, mouth guards), and in some cases, surgery.

There exist options in the field of physical therapy for patients looking for an alternative health approach. Specialized treatment using soft tissue release and joint mobilization, alone, has had a profound affect on the relief of symptoms from a number of TMJ sufferers. Application of intra-oral technique to release the lateral pterygoid and myofascial release to the anterior neck component are two examples of treatment goals. Both techniques help to relieve pressure on the jaw caused by hypertoned muscle groups.

There is a demand placed on oral surgeons and dentists, to address TMJ related complaints, specifically after oral surgery, and dental procedures in which the jaw is open and overstretched (beyond normal range), for a long period of time. A patient may experience trauma to the jaw due to an overstretch injury or invasive dental procedure that has indirectly impacted the jaw. The effects of manual, soft tissue work has had positive effects on majority of patients and serve for a noninvasive treatment option. This further benefits the patient with help of pain management and restoration, optimal and functional range of motion of the TMJ.

Current research shows a link between stress and the TMJ. Specific triggers such as alcohol intake and smoking, for example, have an effect on sleep quality, and therefore, may promote bruxism at night. Bruxism, is a neurologic, sleep movement disorder characterized by grinding or clenching of the teeth in our sleep. This disorder is very damaging to the teeth and the jaw joints, and also causes fatigue and pain to the facial muscles. Lifestyle changes and sleep hygiene techniques are reinforced by the physical therapist, to help maintain optimal TMJ functioning and help manage pain and discomfort.

Treatment and management of TMJ is a joint effort between patients, the dental and professionals and can be effectively treated through specialized physical therapy modalities. DT

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< Page 8B

for thousands of years.[62] Glycyrrhizin is 50 times sweeter than sucrose. It retains, when sapid, a singular liquorice flavour. The liquorice sweetness has a slower onset than sugar and lingers. Unlike artificial sweeteners like aspartame, saccharine, and cyclamates, it contains no sulfur molecule.[63]

For the treatment of bronchial asthma, the root of liquorice (Glycyrrhiza glabra) has been used as a traditional medicine in the East and West. Licochalcone A is the predominant, characteristic chalcone in liquorice root which might be involved in the pathogenesis of virus-exacerbated asthma.[64]

Liquorice is used as a flavorant in a variety of edibles, medicine, and tobacco, and is often innocently consumed in vast amounts without any regard or only with vague concepts of side effects. When imbibed, liquorice acts like hyperaldosteronism which presents with typical symptoms including high blood pressure, low blood potassium, muscle pain and weakness.[65]

Liquorice may induce hypertension[62] because excessive licorice consumption can precipitate a severe hypertensive event through activation of renal mineralocorticoid receptors.[66]

Besides the hypertension problem, liquorice can stain the tongue and teeth. Glycyrrhyzin by itself does not stain teeth, but when combined with dark food dyes, tobacco and/or curries, liquorice is associated with stains. Tooth staining from black liquorice is known, but the tooth staining derives mainly from added dyes to liquorice confections and from liquoricefl avoured tobacco. Liquorice sweets are generally health promoting, pleasurable to eat, and in moderation on their own rarely stain teeth. Accumulation of extracellular polysaccharides from microbial activity contributes to biofilm formation and bacterial plaques. This allows for a tacky gummy surface of muco-polysaccharides to stick to stagnant areas on teeth, and with adherent chromogenic bacteria, liquorice tobacco products discolour teeth and accelerate adjacent gingival breakdown. Quitting the tobacco habit with safe stain removal through scaling and polishing from teeth is feasible.[67]

Heavy tobacco dental staining can be noticed from pipe smoking with Liquorice as an additive. It contributes to increased tobacco staining, especially when included in aromatic pipe tobaccos; the dental stain is directly proportional to the amount and frequency of the pipe smoking. Not only is the palatal and lingual side of teeth prone to accumulating dark tobacco stain but also the mucosa undergoes specific changes. Gingival recession, alveolar bone loss, and periodontal pockets result from the deleterious effect of the tobacco smoke.

Combined with chewing tobacco, liquorice additives enhance and prolong the flavour of the chewing tobacco experience, and consequently damage from longer contact time onto the gingiva, seeming to derive more from tobacco contents rather than just liquorice. Adjacent recession, cervical dentinal staining, and thickening with hyperkeratosis of mucosa are seen.[74]

Frequently liquorice is mixed with dark caramel and food colorings which leave a surface brownish/black tongue stain. This tongue stain is water soluble and usually disappears after a few hours.[74]

Health care workers, including all in the dental team, discovering new hypertension patients, or noting a history of taking diuretics, should always enquire about consumption or use of any liquorice containing product.[67]

Unduly stained teeth, a stained tongue or other oro-dental signs of intraoral chewing tobacco abuse combined with elevated blood pressures, should alert dentists to the possibility of morbidity arising from liquorice toxicity or abuse.[74]

5 - Curry
Curry powder is commonly used spice in many countries of the world. This spice can stain teeth and, if inhaled, it could lead to health problems. Hypersensitivity pneumonitis (HP) is a group of immunologically mediated lung diseases caused by the inhalation of environmental agents (organic dusts from vegetable or animal products), in susceptible individuals.[68] S

Ando reported a case of a man who had worked in a factory that produced curry sauce for 13 years and developed a nonspecific interstitial pneumonia (NSIP) with bronchiolar lesions associated with curry powder and ground pepper.[69]

6 - Portobello Mushrooms
Mushrooms are valuable sources of vitamins such as retinol, thiamine, riboflavin, pyridoxine, and niacin. Portobello has the highest riboflavin and niacin contents.[70] These items are wonderful additions to the entree, but they are also known to stain and discolor teeth.

7 - Mouthwashes that contain Chlorhexidine or Cetylpyridinium chloride:
a - Chlorhexidine:
Chlorhexidine anti-plaque mouthrinses (CHX) remained for a long time as the gold standard for mouthrinses but staining side effects can be seen with this formulation. The tongue is stained a dark blue-gray color but it is not permanent and will fade over time after CHX use is stopped. As for teeth, the stain would have to be polished off by the dentist or hygienist.

Caustic burns of the lips, mouth and tongue have been seen in patients who use mouthwashes containing alcohol and chlorhexidine.[71]
A study showed that CHX mouthrinse was more effective in controlling plaque and gingivitis than chlorhexidine containing toothpaste but caused greatest deposition of extrinsic stains. Supragingival calculus deposition was least in triclosan NaF+ group followed by CHX + triclosan + NaF + ZnCl(2) and CHX. More than half of the subjects reported adverse events during the experimental phase.[72]

Thus,although chlorhexidine digluconate (CHX) is currently the most effective mouthwash for reducing plaque and gingivitis, one of its side effects is extrinsic tooth staining. Interestingly, oxygenating agents may reduce this staining. A review done by Van Maanen-Schakel NW, searched the literature for data concerning the inhibiting effect of an oxygenating agent (OA) on CHX-induced tooth staining. There was moderate evidence that a combination of CHX and an OA reduces tooth staining without interfering with plaque growth inhibition.[73]

Most of the search into stain formation has been carried out on chlorhexidine, although there are other antiseptics which cause staining to a lesser extent and the mechanism proposed could be applicable to staining found with polyvalent metals. The characteristic staining of the tongue and teeth noted by Flotra[74] is not peculiar to chlorhexidine, it has been reported in other cationic antiseptics,[75] an essential oil/phenolic mouthrinse[76] and following prolonged use of delmopinol mouthrinses. There is great individual variation in the degree of staining from person to person, this makes explanation more difficult as it may be caused by intrinsic factors, differences in extrinsic factors or both .Berk suggested that the protein and carbohydrate in the acquired pellicle could undergo a series of condensation and polymerisation reactions leading to discolourationof the acquired pellicle. Chlorhexidine may accelerate formation of the acquired pellicle and also catalyze steps in the Maillard reaction.[2]

The results of a recent study demonstrated that regular use of CPH and chlorhexidine mouthrinses resulted in extrinsic stain accumulation after six weeks, with increased accumulation after 12 weeks versus brushing alone.[77]

Polyvinylpyrrolidone (PVP) (a polymer used as a synthetic blood plasma substitute and in the cosmetic, drug, and food-processing industries) was shown in vitro to reduce chlorhexidine induced, dietary staining without affecting the uptake of the antiseptic to the test substrate. A study in vivo aimed to determine whether PVP affected plaque and dietary staining by a low concentration chlorhexidine rinse. Tooth stain areas were comparable for placebo, 0.03% and 0.06% chlorhexidine rinses, but significantly reduced with the PVP/chlorhexidine rinses compared to the 0.06% chlorhexidine rinse. Tooth stain intensity was significantly increased with 0.06% chlorhexidine rinses compared to placebo and chlorhexidine/PVP rinses. PVP, at the concentrations tested, reduced the stain propensity of a 0.06% chlorhexidine rinse but at the expense of some loss of plaque inhibition.[78]

Addy et al wanted to determine whether a co-polymer anti-adhesive agent would prevent staining by a low concentration chlorhexidine solution. Additionally, the possibility that an essential oil/phenolic rinse product may cause staining. Tooth and tongue staining was significantly increased with 0.2% chlorhexidine compared to the essential oil/phenolic rinse which in turn was signifi-

> Page 10B