Reflections on Dentifrice Ingredients, Benefits and Recommendations

A Peer-Reviewed Publication
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Educational Objectives
The overall goal of this article is to provide dental professionals with information on the active and inactive ingredients in dentifrices and their benefits.

Upon completion of this course, the clinician will be able to do the following:
1. List active ingredients in dentifrices and their therapeutic benefits.
2. List inactive ingredients in dentifrices and their functions.
3. Know the roles of the FDA and ADA with respect to over-the-counter dentifrices.
4. Understand the considerations involved and importance of recommending OTC dentifrices for individual patients.

Abstract
The first major active ingredient introduced into modern-day, over-the-counter dentifrices was fluoride. Since then, dentifrices have been developed with ingredients offering anti-plaque/anti-gingivitis, anti-halitosis, whitening or desensitizing benefits, or a multiplicity of benefits. Given the range of dentifrices currently available, and their differences, a recommendation is important; this should be based on the individual patient’s specific needs and desires and the scientific support for a dentifrice.

Introduction
Toothpastes existed as early as 5,000 B.C., and a toothpaste made from iris flowers was created in the fourth century A.D.1,2 Early modern toothpastes and tooth powders in Europe and America often contained highly abrasive materials such as ground shells, salt, charcoal and chalk.3 Developments continued until the present day. One of the first modern toothpastes contained hydrogen peroxide and baking soda – ingredients still used in dentifrices today. The collapsible toothpaste tube, invented by Dr. Washington Sheffield, revolutionized the use of toothpastes and was a primary factor in their increased popularity. Fluoride, the first major active ingredient, was initially introduced in 1914, and in 1955 fluoride toothpaste demonstrating anti-caries efficacy was introduced (Crest with fluoride).

Current over-the-counter (OTC) dentifrices variously offer preventive, esthetic and treatment benefits. Preventive benefits against caries, plaque/gingivitis, tartar, and halitosis are available, and treatment benefits are offered for dental hypersensitivity. Esthetic benefits, which are not considered therapeutic, include both cleaning and whitening. While some dentifrices offer only cleaning benefits together with fluoride for anti-caries benefits, in recent years dentifrices with multiple benefits aimed at offering solutions to as many potential problems as possible have been introduced. The vast range of available products raises the issue of confusion in the eyes of consumers. This increases the need to understand dentifrice ingredients and benefits, to be able to give patients recommendations on dentifrice use. Recommendations should be based on an individual patient’s specific needs and desires as well as the scientific support for a dentifrice. Both the Food and Drug Administration (FDA) and the American Dental Association (ADA) have played roles in controlling (FDA) and accepting (ADA) dentifrices.

Dentifrice Ingredients
Dentifrices contain both active and inactive ingredients. Active ingredients are those that offer a therapeutic benefit, while inactive ingredients are non-therapeutic and also contribute to the physicochemical properties of the dentifrice – its feel, consistency, sweetness, flavor, pH, texture, abrasiveness and appearance.

Active Ingredients
Active ingredients help prevent caries, sensitivity, plaque/gingivitis, calculus formation and halitosis (Table 1). The first active ingredient included was fluoride.

Table 1. Active ingredients and function

<table>
<thead>
<tr>
<th>Anti-caries</th>
<th>Sodium fluoride</th>
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<tbody>
<tr>
<td></td>
<td>Sodium monofluorophosphate</td>
</tr>
<tr>
<td></td>
<td>Stannous fluoride</td>
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<tr>
<td></td>
<td>Amine fluoride</td>
</tr>
<tr>
<td></td>
<td>Xylitol</td>
</tr>
<tr>
<td>Anti-plaque/anti-gingivitis</td>
<td>Triclosan/copolymer</td>
</tr>
<tr>
<td></td>
<td>Stannous fluoride</td>
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<tr>
<td></td>
<td>Zinc citrate</td>
</tr>
<tr>
<td>Anti-calculus</td>
<td>Tetrapotassium pyrophosphate</td>
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<td></td>
<td>Tetrasodium pyrophosphate</td>
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<tr>
<td></td>
<td>Sodium hexametaphosphate</td>
</tr>
<tr>
<td></td>
<td>Zinc compounds</td>
</tr>
<tr>
<td></td>
<td>Triclosan/copolymer</td>
</tr>
<tr>
<td>Anti-halitosis</td>
<td>Essential oils</td>
</tr>
<tr>
<td></td>
<td>Chlorine dioxide</td>
</tr>
<tr>
<td></td>
<td>Triclosan/copolymer</td>
</tr>
<tr>
<td>Desensitizers</td>
<td>Stannous fluoride/sodium</td>
</tr>
<tr>
<td></td>
<td>hexametaphosphate</td>
</tr>
<tr>
<td></td>
<td>Potassium citrate</td>
</tr>
<tr>
<td></td>
<td>Potassium nitrate</td>
</tr>
<tr>
<td></td>
<td>Potassium chloride</td>
</tr>
<tr>
<td></td>
<td>Stannous fluoride</td>
</tr>
<tr>
<td></td>
<td>Strontium chloride</td>
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</table>

Anti-caries Dentifrices
Fluoride
In the United States, sodium fluoride, sodium monofluorophosphate and stannous fluoride are all used as anti-caries actives. In Europe, amine fluoride is also used and dominates...
the market in some countries, marketed under the brand name Elmex. By supplying topical fluoride on a regular basis, fluoride dentifrices help prevent demineralization and help promote remineralization. If acid attacks occur and result in the loss of ions from the hydroxyapatite crystals, fluoride can be taken up to form fluorapatite crystals. In addition, loss of fluoride ions from the tooth structure is inhibited.

The concentration of fluoride in OTC dentifrices in the United States is typically 1,000–1,100 ppm fluoride, which equates to 0.23% sodium fluoride, 0.76% sodium monofluorophosphate or 0.4% stannous fluoride. The maximum allowable fluoride in OTC dentifrices in the United States is 1,450 ppm. In contrast, in Europe the typical level of fluoride in dentifrices is 1,500 ppm. In either case, the therapeutic level of fluoride in the dentifrice is higher than the level found in OTC fluoride mouthrinses, which typically ranges from 250–900 ppm. Sodium fluoride and sodium monofluorophosphate dentifrices in particular have been extensively researched in clinical trials. The use of fluoride dentifrices (as well as community-based water fluoridation programs) has resulted in substantial declines in caries rates since their introduction, in both urban and isolated communities (for example, a remote island off the west coast of Scotland).

The profound effect of the use of fluoride-containing dentifrices on caries reductions in the developed world has been well recognized. Marinho et al. conducted a meta-analysis of 70 clinical trials on fluoride dentifrices found in the Cochrane Database. Only studies that were controlled, blinded, randomized (or “quasi-randomized”) and conducted in children under 17 years of age were included. Their conclusion was a pooled 24% reduction in D(M)FS, with a range of 21% to 28%. No differences were found in comparing the use of the dentifrices in fluoridated versus non-fluoridated communities. As has been found in studies of topical in-office fluoride agents, the response varied with the level of caries in the population being studied.

Fluoride dentifrices have also been found to be effective in reducing caries rates in a number of studies, with an average plaque reduction of 48% and an average gingivitis reduction of 66% compared to a control dentifrice containing the same level of sodium fluoride but no xylitol. A similar three-month trial in Costa Rica using sodium monofluorophosphate as the fluoride active with 10% xylitol also found DFS reductions of more than 10% compared to a non-xylitol control dentifrice.

**Xylitol**

Xylitol offers anti-caries benefits in dentifrices as well as chewing gums and other vehicles. Xylitol occurs naturally and is found in woods, cereal crops, fruits and vegetables. Acidogenic bacteria are unable to ferment xylitol, reducing their ability to produce the acids necessary for tooth demineralization. It is also believed that the bacteria cannot thrive (a starvation effect) and that over time xylitol-resistant bacteria that are less cariogenic may dominate. In clinical trials, xylitol dentifrices have been found to reduce caries. A three-year double-blind study, by Sintes et al., in Costa Rica in children 8–10 years of age using a sodium fluoride dentifrice containing 10% xylitol found an additional 12.3% reduction in DFS after three years of twice-daily use compared to a control dentifrice containing the same level of sodium fluoride but no xylitol. A similar three-month trial in Costa Rica using sodium monofluorophosphate as the fluoride active with 10% xylitol also found DFS reductions of more than 10% compared to a non-xylitol control dentifrice.

**Anti-microbial (Anti-plaque/Anti-gingivitis) Dentifrices**

Anti-microbial dentifrices offer anti-gingivitis benefits and may also offer an additional anti-caries benefit depending on the agent used. The primary anti-microbial used in OTC dentifrices in the United States is a triclosan/copolymer formulation also containing fluoride (Colgate Total). Stannous fluoride and zinc citrate are also used in dentifrices.

**Triclosan/copolymer**

This formulation contains 0.3% triclosan, a broad-spectrum anti-bacterial agent, together with a copolymer (polyvinyl methylether/maleic acid) that increases the substantivity of the triclosan, with the result it is present and active intraorally. Triclosan is bactericidal and targets the cell cytoplasm. This results in gaps in the bacterial cell membrane and bacterial cell death. Plaque reductions and gingivitis reductions have been found in a number of studies, with an average plaque reduction of 48% and an average gingivitis reduction of 26% found in a review of clinical trials using the triclosan/copolymer formulation. One study found significantly reduced bleeding upon probing scores, with reduced gingivitis, and improved probing attachment levels.
following non-surgical periodontal therapy compared to the control group using a placebo dentifrice. Triclosan/copolymer dentifrice has also demonstrated improvements in healing and anti-inflammatory effects. In vitro, it has been shown to affect inflammatory pathways, specifically through reduced cytokine production, and to inhibit bone resorption. This has potential implications for patients with periodontal disease as reductions in these would reduce the destructive inflammatory response. A fluoride dentifrice containing 0.3% triclosan/0.23% copolymer was found in one study to offer additional caries reductions over and above the effect of fluoride, while a second study found it to be equivalent.

Figure 1. Triclosan/copolymer dentifrice

**Stannous fluoride**

Stannous fluoride dentifrice, containing 0.4% stannous fluoride, also functions as an anti-microbial and is bactericidal. One small study using digital plaque imaging found statistically significant plaque reductions with use of a stannous fluoride dentifrice containing 0.454% stannous fluoride, compared to use of a sodium fluoride dentifrice.

Figure 2. Stannous fluoride dentifrices

Tin retention in saliva was found in another study following in vivo use of stannous fluoride dentifrice. Binney et al. found no differences in plaque regrowth assessed in vivo between a triclosan/copolymer dentifrice and stannous fluoride dentifrice. It should be noted that the subjects involved in the study only rinsed with the dentifrice slurries without any brushing.

**Zinc citrate**

A dentifrice containing 2% zinc citrate together with sodium monofluorophosphate (MFP) for anti-caries benefits has been found in clinical trials to reduce supragingival plaque and gingivitis over three- and six-month periods. Williams et al. found a 25.3% reduction in plaque and an 18.8% reduction in gingivitis after twice-daily use for six months in adults, with greater reductions in more severely affected areas.

**Anti-calculus (Tartar Control) Dentifrices**

Dentifrices containing anti-calculus agents reduce the formation of calculus but do not reduce the levels of preexisting calculus. Calculus forms through calcification of dental plaque and oral epithelial cells by minerals from the saliva and gingival crevicular fluid, and also contains bacteria. Anti-calculus agents, marketed as anti-tartar ingredients, include tetrapotassium and tetrasodium pyrophosphates, sodium hexametaphosphate, and zinc. Pyrophosphates work by stabilizing the calcium level in saliva and interfere with the growth of the crystals that help form calculus. They have also been found to offer anti-microbial benefits.

Zinc compounds used as anti-tartar agents include zinc citrate trihydrate and work by inhibiting crystal growth and controlling bacterial growth. Triclosan/copolymer dentifrice has also been found in several studies to reduce supragingival calculus formation. One study found a 26% at three months and 36% at six months. These function due to the zinc compounds or triclosan/copolymer, and do not contain pyrophosphates.

Figure 3. Anti-calculus dentifrices

**Anti-halitosis Dentifrices**

Chlorine dioxide, essential oils and zinc chloride have all been used to reduce halitosis by inhibiting the production of volatile sulfur compounds. Essential oil dentifrice was found in one study to reduce halitosis. Triclosan/copolymer/fluoride dentifrice has also been found to control and reduce the bacteria associated with volatile sulfur compounds, as well as anaerobic periodontal bacteria, thereby reducing these compounds and halitosis. Stannous fluoride dentifrice with sodium hexametaphosphate has also been found to reduce volatile sulfur compound production.

**Desensitizing Dentifrices**

Desensitizing dentifrices may contain potassium nitrate, potassium citrate, potassium chloride, stannous fluoride or strontium chloride as the active ingredient. Sensitivity occurs
when fluid flows in open dentinal tubules towards the surface of the tooth as a result of hydrodynamic forces (Bränström’s theory), in response to stimuli. This fluid flow is believed to result in the pain associated with hypersensitivity.38 There are two mechanisms by which desensitizing dentifrices can work. The first is by preventing the transmission of neural signals, thereby preventing pain, and the second is by blocking the dentinal tubules.

Potassium nitrate prevents the transmission of neural signals by increasing the level of extracellular potassium (derived from the potassium nitrate contained in the dentifrice), thereby blocking synapses, and has been found in numerous studies over many years to provide effective relief from sensitivity.39 Potassium chloride works in a similar manner.40 Potassium nitrate dentifrice has also been shown to be effective in reducing sensitivity associated with tooth-whitening treatments.41 The FDA monograph considers only 5% potassium nitrate as the percentage required in a desensitizing dentifrice. Stannous fluoride blocks the dentinal tubules,42 and has been shown in several studies to be an effective desensitizer.43,44 It is contained in several dentifrices, including Crest Pro-Health and Gel-Kam gel. A clinical trial assessing stannous fluoride dentifrice (Crest Pro-Health) found a 44% reduction in the mean sensitivity score compared with use of a sodium fluoride dentifrice.45 Stannous fluoride and potassium nitrate are accepted under the ADA Seal of Acceptance program as desensitizers. A potential drawback of stannous fluoride is its propensity to stain teeth; this can be mitigated with cleaning agents.46

Inactive Ingredients
Inactive ingredients in dentifrices include binders, abrasives, surfactants, buffering agents, humectants, preservatives, sweeteners, flavorings and dyes (Table 2).

Table 2. Inactive ingredients and function

<table>
<thead>
<tr>
<th>Binders</th>
<th>Provide body</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prevent separation</td>
</tr>
<tr>
<td>Humectants</td>
<td>Retain moisture</td>
</tr>
<tr>
<td></td>
<td>Prevent dehydration</td>
</tr>
<tr>
<td></td>
<td>Give sweetness</td>
</tr>
<tr>
<td>Surfactants/detergents</td>
<td>Cause foaming</td>
</tr>
<tr>
<td></td>
<td>Reduce surface tension</td>
</tr>
<tr>
<td></td>
<td>Loosen and suspend plaque</td>
</tr>
<tr>
<td>Buffering agents</td>
<td>Control the pH</td>
</tr>
<tr>
<td>Sweeteners</td>
<td>Sweeten the dentifrice</td>
</tr>
<tr>
<td>Flavorings</td>
<td>Provide flavor</td>
</tr>
<tr>
<td>Dyes</td>
<td>Improve appearance</td>
</tr>
<tr>
<td>Titanium dioxide</td>
<td>Give opacity</td>
</tr>
<tr>
<td>Preservatives</td>
<td>Preserve the dentifrice</td>
</tr>
<tr>
<td>Water</td>
<td>Form a paste with the ingredients</td>
</tr>
</tbody>
</table>

Binders are used to provide a dentifrice with body (bulk) and also help to prevent separation of the ingredients. Synthetic cellulose (carboxymethylcellulose), carageenan from seaweed, colloids from mineral sources, carbomers and xanthan gum have all been added as binders/thickening agents. Humectants help the dentifrice retain moisture and prevent it from dehydrating; these include glycerol, which is commonly used, as well as polyethylene glycol, sorbitol and propylene. While not their primary function, humectants also contribute to the sweetness of the dentifrice. Surfactants/detergents reduce surface tension, induce foaming, and help to loosen and suspend plaque.
and debris in an emulsion for easier removal during brushing and interdental cleaning. Common detergents/surfactants include sodium lauryl sulfate and sodium laurylsarcoside. The buffering agents control the pH of the toothpaste, ensuring that it is neither too acidic nor too alkaline. Sweeteners and flavoring agents used in dentifrices do not contain sucrose; sweeteners used include sodium saccharin and sodium cyclamate. Recently, xylitol has increasingly been used as a sweetening agent in toothpastes. FD&C dyes (# 1 and #5) are also included in dentifrices to improve their appearance and acceptability. The inclusion of titanium dioxide provides for opacity in a dentifrice. Finally, water is included to form the paste.

**Abrasives**

Abrasive ingredients used in dentifrices include finely ground calcium carbonate, various silicas, silicon dioxide, magnesium carbonate, dicalcium phosphate dihydrate, aluminum oxide and argonite.

The abrasiveness of a dentifrice is usually measured using the Radioactive Dentin Abrasivity (RDA) test, which uses radioactive dentin and a standard brushing protocol in an in vitro test. The FDA considers an RDA under 250 to be safe and effective. In general, the risk of abrasion is associated more with incorrect brushing technique and/or use of a hard bristled brush than with dentifrice RDA. However, in patients with erosion of the dentition, the lowest RDA dentifrice that still provides cleaning ability should be utilized to avoid increasing the risk of abrasion. Teeth can accumulate stains over time, depending on several factors, including diet, smoking and oral hygiene. Aging also results in changes to the appearance of the color of the tooth. Surface roughness and loss of enamel surface structure alter light refraction, reflection properties and light penetration, resulting in a darker appearance. Abrasives provide cleaning ability, with the intensity of cleaning depending on the type of abrasive used and amount contained in the dentifrice, thereby helping to remove plaque and debris from the tooth surface and also remove extrinsic stains. Without any abrasives, a dentifrice is unable to do this. Typically, the RDA level determines the cleaning ability, with the exception of baking soda, which has an RDA level of 30–40 yet still offers cleaning ability equivalent to more typical RDA levels, believed to be due to the sodium bicarbonate lifting stains as well as the abrasive action of the dentifrice.

In addition to cleaning ability, abrasives with fine, rounded particles also help polish the enamel and thereby increase its luster and white appearance. This is the main mechanism for whitening dentifrices (Colgate Visible White; Crest Whitening Expressions; Crest Vivid White; Colgate Total Advanced Whitening; Aquafresh Extreme Clean). A further option is a dentifrice containing amorphous calcium phosphate (ACP) and baking soda (ARM & HAMMER® Age Defying); the incorporation of ACP helps fill in surface defects, thereby smoothing the tooth surface, enhancing tooth luster and resulting in a whiter appearance. Sodium hexametaphosphate, an anti-calculus agent, has also been found to help inhibit stains. Low levels of hydrogen peroxide have also been incorporated into some whitening dentifrices, with the intent of generating oxygen bubbles that gently help lift debris and stain from the tooth surface. However, the hydrogen peroxide has a very short contact time in this situation.

**Figure 6. Whitening dentifrices**

Role of the Food and Drug Administration

The Food and Drug Administration (FDA) regulates fluoride dentifrices as OTC drugs through the Anti-Caries Monograph. The FDA does not require approval of OTC fluoride dentifrices as new drugs unless they contain ingredients and concentrations that do not fall under the monograph. New Drug Applications for dentifrices are rare, and the requirements imposed by the FDA are stringent. The manufacturer must prove long-term microbiological safety and clinical trials must show efficacy and no toxicity associated with use of the product. Requirements include two clinical trials meeting FDA requirements; laboratory and biological testing. The only recent new drug application and approval for a dentifrice was for one containing the then-new active ingredient triclosan/copolymer (Colgate Total).

**Toothpaste Labeling**

Toothpaste labels contain a list of the active and inactive ingredients, as well as directions and warnings. The dentifrice may or may not carry the ADA Seal. If recommending a dentifrice to a patient, it is important to read the labeling to check if there is any ingredient contraindicated for the patient (for instance, allergies to certain dyes) as well as the warnings section of the label. Stannous fluoride dentifrices are required by the FDA to carry a warning that staining may occur. Additionally, dentifrices indicated as desensitizers carry the warning that the
product should not be used for more than four weeks unless recommended by a dentist or physician.

The FDA does not test dentifrices, although it can carry out audits to check that manufacturers are complying with the monograph and good manufacturing practices.

The ADA Seal
Manufacturers can choose whether or not to apply for an ADA Seal, which requires documentation, ADA-mandated standardized testing and considerable resources. Until recently, the ADA Seal was available for both professional and consumer products. The professional seal program was discontinued and phased out by the end of 2007.53 To qualify for an ADA Seal, the manufacturer must submit the list of ingredients, indications and claims; clinical trials; laboratory tests in accordance with the ADA Seal program requirements that document efficacy and safety and support marketing claims, as well as submit good manufacturing practices (GMP) and facilities documentation.54,55 The manufacturer must provide copies of all product packaging and labeling for review and approval by the ADA, and comply with the ADA’s standards for accuracy and truthfulness.

The ADA Seal for fluoride dentifrices is for anti-caries efficacy and safety— if a manufacturer wishes to have other indications considered, data must be submitted that backs up the indication and associated claims. The logo is always the same, while the wording alongside the logo differs and depends on what the ADA acceptance was for. Therefore, it is important to read the wording in the box by the seal. The standard statement is as follows: “The ADA’s Council on Scientific Affairs Acceptance of (Product Name) is based on its finding that the product is effective in helping prevent or reduce tooth decay when used as directed.”

For products carrying the seal, a new application must be made if the formulation changes, or every five years, whichever is sooner. The ADA Seal program does not support plaque reduction as a claim since this is not the therapeutic benefit. Instead, the program supports an anti-plaque/anti-gingivitis claim if the manufacturer’s submitted documentation supports such a claim and the manufacturer requests it. One of the ADA’s requirements is that manufacturers place a statement regarding use of a pea-sized amount by young children to help prevent fluorosis. The actual statement is as follows: “Do not swallow. Use only a pea-sized amount for children under six. To prevent swallowing, children under six years of age should be supervised in the use of toothpaste.”
if a desensitizing dentifrice is not required it may mask other problems such as early cavities or erosion – hence the four-week labeling requirement. If a patient requests a whitening dentifrice, recommending one may help patient compliance with oral hygiene and considerations should include determining what other needs the patient has – for instance, anti-plaque/anti-gingivitis and/or anti-tartar benefits. Is the patient’s desire for a whitening toothpaste due to surface staining or changes in the enamel surface that alter light properties – suggesting use of a dentifrice with fine polishing capability or use of an ACP dentifrice (to either remove or fill in microscopic defects in the enamel). If the patient suffers from erosion, a low RDA dentifrice should be selected. For multi-benefit dentifrices, which benefits would most help a specific patient? Does the patient acquire calculus readily or require a desensitizer or experience halitosis? Would the patient benefit from anti-microbials, and if so is the patient’s periodontal status such that anti-inflammatory activity would be desirable? Patients anticipate receiving recommendations. These can be explicit or implicit. If you provide patients with samples of toothpastes, this is an implicit recommendation even if you have not discussed or actively recommended a dentifrice. In all situations, dentifrice selection should consider the available supporting science.

Summary
The range of OTC dentifices available today enables consumers to use a dentifrice tailored to their individual needs and desires. Dental professionals play an important role in helping patients select an appropriate dentifrice. Dentifrices offer therapeutic and cosmetic benefits, with the range of benefits varying with the ingredients in a specific dentifrice. Considerations should include the support and documentation for the dentifrice, and the needs of the patient.

References

Author Profile

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Dr. Fiona M. Collins has authored and presented CE courses to dental professionals and students in the US and internationally. During her career she has worked in the United States, Middle East, The Netherlands and United Kingdom. In addition to clinical dentistry, she has held positions in academia, marketing, professional relations, education and training, and general management while at Groningen University, Straumann, Colgate Oral Pharmaceuticals and Timken. Dr. Collins is a past member of the Academy of General Dentistry Foundation Strategy Board, and has been a member of the British Dental Association, Dutch Dental Association, and the International Association for Dental Research. Dr. Collins earned her dental degree from Glasgow University and holds an MBA and MA from Boston University. She has been an active consultant in the dental industry for several years, and a national and international speaker. Dr. Collins is a member of the American Dental Association and the Organization for Asepsis and Safety Procedures.

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1. Ancient toothpastes were formulated containing ___________.
   a. ground shells
   b. iris flowers
   c. carbamide peroxide
   d. a and b

2. The collapsible toothpaste tube was invented by ___________.
   a. Dr. Alberto Gomez
   b. Dr. Washington Sheffield
   c. Dr. Sheffield Washington
   d. Dr. Brian Thompson

3. The first active ingredient introduced into dentifrices was ____________.
   a. sodium lauryl sulfate
   b. fluoride
   c. zinc citrate
   d. xylitol

4. An active ingredient in a dentifrice is one that offers ____________.  
   a. an esthetic benefit
   b. a therapeutic benefit
   c. a higher level of the same benefit offered by an inactive ingredient
   d. a benefit enhanced by physical activity

5. An inactive ingredient in a dentifrice is one that ____________. 
   a. is nontherapeutic
   b. functions in the same way as an active ingredient but at a lower level
   c. contributes to the physicochemical properties of the dentifrice
   d. a and c

6. The supply of topical fluoride from regular use of a dentifrice ____________.
   a. helps prevent demineralization
   b. helps promote remineralization
   c. inhibits loss of fluoride ion from the tooth structure
   d. all of the above

7. The use of fluoride dentifrices has resulted in substantial declines in the caries rate.
   a. True
   b. False

8. The use of 250 ppm fluoride dentifrice in children has been found to ____________ compared to use of regular fluoride dentifrices.
   a. reduce the risk for fluorosis
   b. slightly reduce the anti-caries benefit
   c. improve a child's attitude to brushing
   d. a and b

9. The use of xylitol as an active ingredient in dentifrices has been found to reduce caries.
   a. True
   b. False

10. The mechanism of action for xylitol involves the bacteria which ____________.
    a. are not able to ferment xylitol, reducing their ability to produce acids
    b. cannot thrive on xylitol
    c. may shift over time to xylitol-tolerant, less acidogenic bacteria dominating the flora
    d. all of the above

11. Anti-microbials used in dentifrices in the United States include ____________.
    a. triclosan/copolymer
    b. stannous fluoride
    c. zinc citrate
    d. all of the above

12. Triclosan ____________.
    a. is bactericidal
    b. attacks the bacterial cell cytoplasm
    c. results in gaps in the cell membrane and cell death
    d. all of the above

13. Average plaque and gingivitis reductions of 48% and 26% respectively have been found in a review of triclosan/copolymer dentifrice.
    a. True
    b. False

14. In vitro, triclosan/copolymer dentifrice has been found to ____________.
    a. reduce cytokine production
    b. inhibit bone resorption
    c. affect inflammatory pathways
    d. all of the above

15. Using digital plaque imaging, statistically significant plaque reductions have been found with use of a stannous fluoride dentifrice.
    a. True
    b. False

16. Tin retention in saliva has been found after using stannous fluoride dentifrice.
    a. True
    b. False

17. Plaque and gingivitis reductions of up to ____________ and ____________, respectively, were found in severely affected areas in a six-month clinical study of zinc citrate dentifrice used twice daily.
    a. 19.3%; 15.8%
    b. 22.3%; 18.8%
    c. 25.3%; 18.8%
    d. 28.3%; 23.8%

18. Anti-calcus agents used in dentifrices include ____________.
    a. pyrophosphates
    b. zinc
    c. sodium hexametaphosphate
    d. all of the above

19. Anti-calculus (tartar control) dentifrices work variously by ____________.
    a. inhibiting, or interfering with, crystal growth of calculus
    b. inhibiting bacterial growth
    c. stabilizing the level of calcium present in saliva
    d. all of the above

20. If a patient is sensitive to pyrophosphates, an anti-calculus dentifrice that does not contain these should be recommended and used, with options including one containing ____________.
    a. triclosan/copolymer
    b. charcoal
    c. zinc citrate trihydrate
    d. a or c

21. The mechanisms by which desensitizing dentifrices work are by ____________.
    a. blocking nerve transmission of the response to stimuli
    b. blocking (occluding) the dentinal tubules
    c. competitive stimulation
    d. a and b

22. The surfactant in a dentifrice ____________.
    a. causes foaming
    b. reduces surface tension
    c. helps loosen and suspend plaque
    d. all of the above

23. Abrasiveness in a dentifrice ____________.
    a. Is measured in vitro by the Radioactive Dentin Abrasivity (RDA) test
    b. Is considered safe and effective by the FDA at an RDA below 250
    c. helps remove plaque, debris and stains from the teeth
    d. all of the above

24. A whitening dentifrice can work by ____________.
    a. polishing the surface of the enamel with fine, rounded abrasives
    b. removing microscopic surface defects
    c. filling in microscopic surface defects
    d. all of the above

25. While the ADA Seal for fluoride dentifrices is for anti-caries efficacy and safety, the manufacturer can have other indications considered provided data supporting the additional indication(s) and associated claims is submitted to the ADA.
    a. True
    b. False

26. The FDA labeling requirement for stannous fluoride dentifrices include a statement concerning the possibility of surface staining of the teeth.
    a. True
    b. False

27. Desensitizing dentifrices must carry a warning mandated by the FDA that the product should not be used for more than ____________ unless recommended by a dentist or physician.
    a. two weeks
    b. four weeks
    c. six weeks
    d. eight weeks

28. If a patient suffers from erosion, a low RDA dentifrice should be selected.
    a. True
    b. False

29. An implicit recommendation occurs when a dental professional provides a patient with a sample of, for instance, a dentifrice in the absence of an active recommendation, while an explicit recommendation involves an active recommendation.
    a. True
    b. False

30. A dentifrice recommendation should consider ____________.
    a. the individual patient’s needs and desires
    b. the scientific support and documentation for the dentifrice
    c. any patient-specific contraindications, allergies or sensitivities
    d. all of the above
**Eduational Objectives**

1. List active ingredients in dentifrices and their therapeutic benefits.
2. List inactive ingredients in dentifrices and their functions.
3. Know the roles of the FDA and ADA with respect to over-the-counter dentifrices.
4. Understand the considerations involved and importance of recommending OTC dentifrices for individual patients.

**Course Evaluation**

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Rating</th>
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<tbody>
<tr>
<td>1. Were the individual course objectives met?</td>
<td></td>
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<tr>
<td>Objective #1: Yes No</td>
<td></td>
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<tr>
<td>Objective #2: Yes No</td>
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<tr>
<td>Objective #3: Yes No</td>
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<tr>
<td>Objective #4: Yes No</td>
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<td>2. To what extent were the course objectives accomplished overall?</td>
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<td>5 4 3 2 1 0</td>
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<tr>
<td>3. Please rate your personal mastery of the course objectives.</td>
<td></td>
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<tr>
<td>5 4 3 2 1 0</td>
<td></td>
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<tr>
<td>4. How would you rate the objectives and educational methods?</td>
<td></td>
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<tr>
<td>5 4 3 2 1 0</td>
<td></td>
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<tr>
<td>5. How do you rate the author’s grasp of the topic?</td>
<td></td>
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<tr>
<td>5 4 3 2 1 0</td>
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<tr>
<td>6. Please rate the instructor’s effectiveness.</td>
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<tr>
<td>5 4 3 2 1 0</td>
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<tr>
<td>7. Was the overall administration of the course effective?</td>
<td></td>
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<tr>
<td>5 4 3 2 1 0</td>
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<tr>
<td>8. Do you feel that the references were adequate?</td>
<td></td>
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<tr>
<td>Yes No</td>
<td></td>
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<tr>
<td>9. Would you participate in a similar program on a different topic?</td>
<td></td>
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<tr>
<td>Yes No</td>
<td></td>
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<tr>
<td>10. If any of the continuing education questions were unclear or ambiguous, please list them.</td>
<td></td>
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<tr>
<td>________________________________________________________________________</td>
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<tr>
<td>11. Was there any subject matter you found confusing? Please describe.</td>
<td></td>
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<tr>
<td>________________________________________________________________________</td>
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<tr>
<td>12. What additional continuing dental education topics would you like to see?</td>
<td></td>
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<tr>
<td>________________________________________________________________________</td>
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</tbody>
</table>

**PLEASE COPY­ophon ANSWER SHEET FOR ADDITIONAL PARTICIPANTS.**

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**EDUCATIONAL DISCLAIMER**

The author of this course has no commercial ties with the sponsors or the providers of the unrestricted educational grant in this course.

**INSTRUCTIONS**

All questions should have only one answer. Grading of this examination is done manually. Participants will receive notification of passing by receipt of a verification form. Verification forms will be mailed within two weeks after taking the examination.

**Course Credits/Cost**

All participants scoring at least 75% (21 or more questions correctly) on the examination will receive a certificate for earning 4 CE credits. The internal continuing education program of this sponsor is accepted by the AGD for Fellowship/Mastership credit. Participants are urged to check their state dental board for acceptance. The California Provider number is 4527. The cost for courses ranges from $49.00 to $110.00.

**Records of receipt**

PennWell maintains records of successful completion of any program. Please contact our offices for a copy of your continuing education credits report. This report, which will list all credits earned to date, will be generated and mailed to you within five business days of receipt.

**CANCELLATION/REFUND POLICY**

Any participant who is not 100% satisfied with this course can request a full refund by contacting PennWell in writing.

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