Dry Mouth Syndrome and the Emerging Role of Arginine-Based Technologies

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Learning Objectives: After reading this article, the individual will learn: (1) causes and health complications of dry mouth syndrome and the dental professional’s role in diagnosing and managing this condition, and (2) the emerging role of arginine-based technologies in the management of dry mouth syndrome.

About the Authors

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Hyposalivation and xerostomia, sometimes referred to as “dry mouth syndrome,” is an increasingly common condition that increases the risk for dental caries, periodontal disease,1 dental hypersensitivity,3 4 and oral candidiasis.1-5 Dry mouth also leads to many quality-of-life issues. The clinical diagnosis of hyposalivation is defined by either decreased salivary flow or insufficient saliva. Xerostomia, a more subjective term, is the perception of not having enough moisture in the mouth. Changes in salivary composition can also lead to the feeling of a dry mouth.1-7 The terms dry mouth syndrome, dry mouth, and xerostomia are used interchangeably in the literature to describe all of these conditions, despite the various etiologies of each disorder.

While some may experience transient xerostomia symptoms, most cases of dry mouth are chronic, characterized by complex, multifactorial etiologies.1-7 Despite the origin, dental professionals need to understand the components of healthy saliva, recognize factors that lead to dry mouth, appreciate the role of saliva in both homeostasis and disease, provide thorough screening techniques, and be able to offer appropriate therapies and interventions to those who suffer from xerostomia and its subsequent sequelae.8

DENTAL PROFESSIONALS are on the front line for monitoring changes in salivary flow rates or composition. The risk for
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Dental disease increases significantly when the salivary flow rate is reduced to the point where oral physiology is altered sufficiently to disrupt homeostasis.8-12,15

Healthy saliva is primarily (99%) water. In addition, saliva contains a complex mix of proteins, enzymes, mucins, and buffering compounds, making saliva a very sophisticated fluid. Ninety percent of whole saliva comes from 3 major glands (parotid, submandibular, and sublingual). Minor salivary glands throughout the mouth are responsible for the remaining 10% of saliva.16-17

On average, salivary flow rates can vary from 0.5 to 1.5 liters per day. The submandibular and minor salivary glands produce most of the resting, unstimulated saliva, which is a mix of serous and mucous secretions. Parotid gland secretions, a major source of stimulated saliva, are primarily serous secretions, whereas sublingual glands contribute both mucous and serous secretions.16,17

Salivary flow rates vary per individual. The flow rate for normal, unstimulated saliva is 0.25 to 0.4 mL/minute, which is also called the resting flow rate. While 0.1 mL/minute or less is considered abnormal, a resting flow rate between 0.1 and 0.25 mL/min is considered low and less than 0.1 is considered very low.16,17

One way to determine the simulated salivary flow rate is to have a patient spit into a cup while chewing a piece of sterile wax for 5 minutes. Normal stimulated whole saliva flow is 1.0 to 3.0 mL per minute; 1.0 mL/min to 0.7 mL/min is considered low, and rates below 0.7 mL/min are considered very low.16,17

Visual inspection of the mucosa inside the lips can also aid in detection of dry mouth.13 Upon retracting the lower lip and drying with gauze, within one minute, there should be many tiny drops of saliva on the mucosa, a product of the minor salivary glands located just under the mucosal surface. Those with sufficient salivary flow will also have saliva pooling in the floor of the mouth.

Salivary pH is also important, but is highly variable. Salivary pH can vary significantly due to a number of factors, but the pH of healthy resting saliva flow will fall in the range of 6.8 to 7.2. Saliva in this range favors homeostasis, creating an environment that supports remineralization, the suppression of pathogenic microbes, and the growth of nonpathogenic oral microflora. Healthy saliva also contains sufficient levels of bicarbonate ions and other proteins that can buffer acids.3,16,17 Those with a low salivary flow rate typically have a more acidic salivary pH.18

When salivary glands are stimulated, the quality of saliva improves as the concentration of protein increases along with increased levels of sodium, chloride, and bicarbonate.19 The bicarbonate concentration, also known as buffering capacity, is considered critical due to its immediate buffering effect on acidogenic pathogenic plaque. Stimulating saliva after a meal with sugarless gum can be an effective way to neutralize plaque acids and decrease caries risk. 

Stimulating saliva after a meal with sugarless gum can be an effective way to neutralize plaque acids and decrease caries risk. The reserves of bicarbonate within the salivary glands are not unlimited, and the salivary proteins provide a secondary pathway for neutralizing plaque acids.

Although the field of diagnostic sialochemistry is still emerging, saliva is now recognized as an incredibly complex fluid comprised of an ever-expanding number of proteins, lipids, and inorganic ions. Many salivary proteins contain a large amount of the amino acid proline, referred to as proline rich proteins (PRPs). These PRPs make up 70% of the salivary proteins and are responsible for the formation and function of the acquired enamel pellicle.20 However, the less abundant amino acid, arginine, is found free in saliva and as part of peptides and proteins, and plays a significant role in modulating the plaque pH using interaction with oral bacteria to create ammonia.

Salivary pH and Erosion-accelerated Demineralization

Homeostasis is a basic tenet for wellness. The ultimate goal is to achieve and maintain a healthy pH balance in the oral cavity, which in turn nurtures the growth of a mutually symbiotic biofilm. Demineralization won’t occur or progress when the oral pH is maintained above the critical pH for hydroxyapatite and fluorapatite. This critical pH range is a dynamic number dependent on the calcium and phosphate levels in the saliva. The oral environment is not negatively affected when the oral pH remains above 6.5. As the pH drops below 5.5, the tooth begins to lose valuable calcium and phosphorus ions on a microscopic level. When dental tissues are repeatedly exposed to lowered pH for protracted periods of time, the risk for both caries and hypersensitivity increases.3

Hydroxyapatite, the prime calcium phosphate in teeth, is vulnerable when the pH falls below 5.5; however, when fortified with fluoride, hydroxyapatite becomes fluorapatite, which can withstand pH values as low as 4.5. Since the composition of dentin includes collagen and less inorganic content, root surfaces demineralize at a pH higher than that of enamel. Depending on factors such as the presence of fluoride or cementum, the critical pH for root surfaces is often higher than pH 6, a significant issue as more people remain dentate throughout life.3
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Erosion, classified as the loss of hard tooth structure that does not involve bacterial activity, is considered the leading cause of dentinal hypersensitivity. In addition, research has shown that patients with hypersensitivity have 8 times more open dentinal tubules that are twice the mean diameter than those who do not have this problem. Dentinal hypersensitivity, fueled by dietary factors and the increase in xerostomia, is rising in all age groups, and young children are increasingly showing signs of developing hypersensitivity.

**DRY MOUTH: A MICROBIAL BIOFILM PARADISE**

Most microbes live in complex, polymicrobial communities. Healthy biofilms are aerobic, while pathogenic microbial communities are dysbiotic. Caries and periodontal disease are complex biofilm-based infections but each is associated with different microbes that can be either aerobic or anaerobic. The bacterial biomass in periodontal disease increases as inflammation increases due to dysbiotic organisms that both trigger and extend inflammatory periodontal disease.

As the science of cariology has progressed, caries is now considered a pH-mediated disease. Dry oral environments favor the proliferation of acidogenic cariogenic pathogens, such as *Streptococcus mutans* and *Lactobacillus* spp., because there is a lack of salivary buffers which can neutralize plaque acids. When the plaque pH drops into the acidic range, aciduric microbes in oral biofilm not only change their gene expression to tolerate the acidic pH environment but also begin to produce acid, contributing to continued low pH levels.

*S mutans* and *Lactobacillus* spp. have long been associated with the caries process and are relatively easy to identify and culture, but research has shown 10% of subjects with rampant caries do not have detectible levels of *S mutans*. *Candida albicans* is often present in plaque biofilms of children with early childhood caries. The microbial complexity and diversity within plaque of children with severe early childhood caries is much less than within caries-free children. Root caries in elderly patients is associated with complex, polymicrobial communities that vary from subject to subject; however, *S mutans*, lactobacilli, and *Actinomyces* are typically present. Dozens of acidogenic and aciduric microbes are now implicated in the caries process, with some organisms favoring specific tooth surfaces or primary or secondary dentition.

The incidence of oral candidiasis is increased in patients with dry mouth. *C albicans*, a common and aggressive fungal organism, favors a highly acidic environment. *C albicans* contributes to the overall low pH and thickness of the biofilm. Various studies now indicate that *C albicans* may play an active role in both the development of caries and early childhood caries, and can be associated with periodontal disease.

It is now well understood that salivary flow rates have a profound effect on the composition of both the saliva and plaque biofilm. Low flow rates tend to translate to low salivary pH and biofilm masses.

**MULTIPLE BENEFITS FROM A COMPLEX FLUID**

Dry mouth issues impact daily life. Healthy saliva, in sufficient quantities, contributes to mastication, verbal communication, digestion, comfortable respiration, and sexual activities. Activities such as speaking, singing, and whistling are compromised when the mouth is dry. Adequate saliva helps people chew food, improves the taste of food, and combines with food to form a bolus, which facilitates swallowing and keeps food from sticking to the teeth. Saliva lubricates and supports mucosal integrity, has antimicrobial properties, contains digestive enzymes, buffers acids, helps form a protective pellicle on tooth surfaces, and is a rich source of calcium and phosphate, which are minerals necessary for maintaining the ionic balance of the oral environment, especially the teeth.

*Adequate saliva helps people chew food, improves the taste of food, and combines with food to form a bolus, which facilitates swallowing.*

**QUALITY OF LIFE**

Insufficient saliva has a direct impact on how food tastes. When food is not appetizing or does not taste normal, people lose interest in eating—this causes many elderly to become anorexic. Adequate nutritional intake supports a healthy immune system and aids in preservation of valuable muscle mass.

Raw foods or foods that have significant structural integrity can irritate mucosal tissues that may already be sore and compromised due to dryness. People who suffer from dry mouth frequently alter their food intake, preferring soft, highly processed foods or even liquid nutritional supplements and/or beverages that require less or no chewing. In addition, these types of foods are generally high in fermentable carbohydrates, a characteristic that increases the risk for dental caries. Other people dramatically increase their beverage intake frequency, often sipping on sweet soft drinks throughout the day to ease the dry mouth discomfort.
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Those with dry mouth are often encouraged to take small sips of water throughout the day, a recommendation that can have unintended consequences. Plain water moistens the mouth but can’t compare to saliva’s rich fluid complex. Water dilutes the benefits of any existing salivary proteins. In addition, increasing fluid intake results in more frequent urination, which can lead to sleep disruption.

**MEDICAL CONDITIONS AND LIFESTYLE**

It often takes years to get an accurate diagnosis of hyposalivation or xerostomia. Some healthcare providers consider dry mouth a vague symptom or a life inconvenience. Dry mouth is now a well-recognized complication for a number of medical conditions including the following: autoimmune disorders, radiation treatment to the head and neck area, salivary gland dysfunction, xerostomia.

Saliva production can be stimulated with pharmaceuticals such as pilocarpine and cevimeline, which are muscarinic agonists.

chronic renal failure, HIV/AIDS, Parkinson's disease, and diabetes. Xerostomia is also an issue for those who experience hormonal imbalances, nasal blockage, sleep apnea, chronic obstructive pulmonary disease, and gastric esophageal reflux disease. Typically, there are natural decreases in salivary flow with age, especially in female patients. Decreased estrogen levels as a result of either natural or surgically induced menopause can cause a decrease in salivary flow. While Sjögren's syndrome is the classic dry mouth disease, dry mouth is a frequent symptom for many autoimmune disorders. Interestingly, females make up the majority of those diagnosed with an autoimmune disorder. It is not uncommon to have more than one condition. Autoimmune disorders tend to cluster in families; however, members of the same family may have different conditions.

Dry mouth is the most common side effect for both prescribed and over-the-counter (OTC) medications. A wide range of medications can mediate or potentiate dry mouth issues. Medications used to control or modulate hypertension, anxiety, depression, pain, seasonal allergies, asthma, appetite control, and nausea can each contribute to xerostomia. Medical marijuana also creates dry mouth.

Seniors are at the highest risk for dry mouth for 2 different reasons. They are more likely to have one or more diseases that cause dry mouth, and that age cohort has higher rates of polypharmacy. It is estimated that those older than the age of 60 take on average 3 medications daily, increasing the overall risk for xerostomia.

Contemporary lifestyles may also play a contributory role. Dehydration can occur from insufficient fluid intake or prolonged exposure to low levels of humidity in desert climates, cold winter air, or indoor air that is either artificially heated or cooled. Even emotional conditions such as stress and anxiety can have negative effects on salivary flow. Cigarette smoking and recreational drugs such as methamphetamines and cannabis or even laxative overuse are known causes of dry mouth. Caffeine and alcoholic beverages are diuretics, and foods high in sodium such as salty snacks and highly processed foods add to the problem. Most mouthrinses contain a significant amount of alcohol, a necessary ingredient to keep therapeutic ingredients active, but alcohol can exacerbate oral dryness for those at risk. Oral appliances such as partial dentures, sports mouthguards, removable orthodontic aligners, bruxism appliances, and whitening trays create a physical barrier between teeth and saliva, creating a temporary dry environment. Even seemingly innocuous activities such as strenuous exercise, wearing a continuous positive airway pressure machine, or prolonged speaking can contribute to dry mouth.

**WAYS TO COMBAT DRY MOUTH**

**Improving the Salivary Flow Rate**

Two parallel factors are necessary to create and support oral homeostasis in those suffering from dry mouth and subsequent oral diseases: improve the salivary flow rate and enhance the quality of saliva. Until recently, the options available to relieve dry mouth issues were quite limited. Patients were often advised to take frequent sips of water, a recommendation that had limited, unsustainable benefits, or to suck on lemon drops, a practice fraught with problems. Lemon drops contain citric acid, which stimulates saliva, but citric acid has the capacity to demineralize tooth structure via chelation, leading to the loss of valuable tooth ions, an unintended consequence of a protocol often recommended by medical professionals.

Saliva production can be stimulated with pharmaceuticals such as pilocarpine and cevimeline, which are muscarinic agonists. Both of these are able to stimulate salivary flow due to their cholinergic effects, and consequently, they have the potential to interact with cardiac medications and cause other undesirable side effects such as excessive sweating. When patients are either unable to or choose not to take systemic medications to induce salivation, saliva replacements are the next most logical choice to alleviate dry mouth. Saliva replacements do not...
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mimic natural saliva, but instead usually contain a buffering agent, cellulose, and flavoring. Since they frequently lack the natural enzymes found in saliva, they do little more than provide transient relief from the discomfort associated with dry mouth syndrome.

Xylitol, a 5-carbon polyol, is a naturally occurring, plant-derived substance known to stimulate salivary flow. Increasing salivary flow increases the concentration of bicarbonate, raising the pH above a neutral range,32 favoring remineralization of tooth structure via calcium, fluoride, and phosphate. However, it’s important to remember that long-term stimulation of salivary flow will lead to a decrease in salivary buffering. *S. mutans* can uptake xylitol but is incapable of metabolizing this nonfermentable carbohydrate.42-44 The regular use of xylitol products throughout time shifts the oral ecology, favoring commensal microbes, which are not aciduric, and acidogenic, but are associated with oral health. The wide variety of xylitol products helps increase the likelihood that patients can find a therapeutic that is easy to use.

Several products are now available that contain spilanthes extract, a naturally derived herbal substance, known since biblical times as the toothache plant. Spilanthes creates a tingling feeling in the soft tissue and is reported to stimulate salivary flow for a limited time period.

### Alkaline Generating Pathways

Dental caries, erosion, and erosion-based dentinal hypersensitivity are all environmentally driven oral conditions. It is well understood that low pH levels have a direct impact on the development of all 3.1,3,6 Much attention is now being paid to alkaline generating pathways as a mechanism to establishing homeostasis in the oral cavity. Saliva contains both urea and arginine, substances that can contribute to increases in pH levels in both saliva and biofilm.45

Urea is found in saliva and gingival crevicular fluid. Several species of bacteria use urease to break down urea, and the major byproduct is ammonia, an alkali. Shu et al46 concluded that plaque biofilm urease levels were closely associated with caries activity levels, with caries-free (CF) individuals having high levels of urease activity and caries-active (CA) subjects exhibiting low plaque urease levels.

Salivary levels of arginine are typically low, but salivary proteins and polypeptides contain abundant levels of this amino acid. Arginine is released as proteins and polypeptides that are metabolized via the arginine diamminase system (ADS). ADS is a 3-enzyme metabolic pathway that creates 2 ammonia molecules, in addition to the production of adenosine triphosphate molecules that supply cellular energy.45

Arginine metabolism by bacteria within the plaque can moderate the biofilm pH. Bacteria employ ADS to break down arginine, but there is great variation in argynolytic activity, directly related to pH, oxygen levels, and the availability of carbohydrates and arginine.47 Insufficient buffering, the presence of sucrose, or a low pH can also impact the metabolism of arginine, resulting in a lower alkali production. Both the initiation and progression of caries activity is influenced by acid/base formation in the oral cavity.48 Those at high risk for caries tend to have lower ADS activity levels. In a recent study of 100 children, Nascimento et al49 found plaque located on noncarious tooth surfaces had higher ADS activity than plaque samples obtained from caries lesions.

Gordan et al50 found CF subjects had significantly higher ammonia levels in both saliva and plaque from arginine activity as compared to CA subjects. Urease levels were 3 times higher in CF subjects. Reyes et al51 recently published a report demonstrating that CF subjects had higher salivary and plaque ammonia levels via urease and ADS activity than CA subjects. Nascimento et al52 studied ammonia generation in CA, CF, and caries-experienced (CE) adults. Significantly higher levels of salivary ADS activity and plaque urease activity were observed in CF adults, and CA subjects had significantly higher levels of *S. mutans* in both their saliva and plaque.

### Using Arginine-Based Chemistry to Inhibit Caries Lesions and Reverse Demineralization

Caries is a 2-stage process. Initially, tooth structure degrades in the presence of excess concentrated acids. This process continues when there is insufficient alkali to counteract the acid attack and an inadequate mineral source to initiate remineralization. In early stages, it is possible to reverse the damage to the tooth. While the acidogenic microbes, *S. mutans* and *Lactobacillus* spp. have been studied extensively for their role in demineralizing tooth structure, other acidogenic and aciduric microbes are known to be involved as well.7,23

Kleinberg’s pioneering work23 on the impact of arginine in the oral environment has led to a more complete understanding of the dynamics of caries and erosion, leading to new approaches for preventing and modifying both conditions. Kleinberg23 postulated that plaque could be less cariogenic if there was a large proportion of argynolytic bacteria present. Early research demonstrated argynolytic bacteria had a different and greater effect on oral biofilm pH than ureolytic microbes53 and that arginine degradation was optimal when the pH was closer to neutral.54

In 2002, Kleinberg23 described a novel anticaries formula called CaviStat (Ortek Therapeutics). This arginine bicarbonate/calcium carbonate formula contained the necessary...
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Ingredients to initiate arginolytic activity and neutralize acids while also providing calcium for remineralization. Initial research involving CaviStat technology confirmed the benefits. A CaviStat-containing dentifrice used more than a 2-year period was clinically and statistically more effective in inhibiting the formation and progression of caries in children as compared to subjects in a control group that used a 1,100 ppm fluoride toothpaste. A follow-up, randomized clinical trial involving 200 children concluded that a CaviStat mint confection both inhibited caries onset and caries progression.

Mounting evidence regarding the benefits of arginine-calcium carbonate technology led Colgate-Palmolive to acquire both a professionally applied product and a dentifrice that contained these ingredients. The compound was renamed Pro-Argin. Numerous papers published in 2013 reported favorable benefits from using a commercially available fluoride dentifrice containing 1.5% arginine with an insoluble calcium component. In a 4-week, double blind, randomized clinical trial, Wolff et al. demonstrated that the new dentifrice modulated plaque metabolism, increased ammonia production, and decreased lactate production, thereby resulting in a pH-neutral oral environment. A study by Nascimento et al. demonstrated increased ADS plaque activity among CA subjects more than a 4-week period of time and a corresponding shift in bacterial composition similar to the CF subjects, suggesting the creation of a healthier oral biofilm.

The most compelling caries trial to date is a double blind, randomized 2-year study of 6,000 children who were classified as low to moderate risk for caries. Typically, studies focus on high-risk populations, not populations that are low risk for disease. Subjects were assigned to 3 test groups. The control group used a standard 1,450 ppm fluoride while the 2 test groups used a 1.5% arginine dentifrice that contained either di-calcium phosphate or calcium carbonate. Subjects in both arginine-fluoride paste groups each had a 16.5% lower DMFS score over the study period compared to the control group, demonstrating significant reductions in both surfaces scores as well as overall DMFT scores. Hu et al. reported that a 1.5% arginine fluoride calcium dentifrice produced clinically harder tooth surfaces, demonstrating effectiveness in arresting and reversing root caries lesions. To date, arginine calcium-based fluoride (ProArgin) toothpaste is readily available in most retail markets outside of the United States.

**Treating Erosion-Based Dentinal Hypersensitivity With Arginine Technologies**

Numerous studies report the positive benefits derived from using a professionally applied 8% arginine calcium carbonate paste to reduce dentinal hypersensitivity. Subjects treated with a 8% arginine-calcium carbonate paste reported statistically significant reductions in sensitivity using tactile and air-blast tests, both immediately after application and at post-treatment examinations 4 and 12 weeks later. The product has also been used to decrease dentinal hypersensitivity following periodontal therapy. Subjects professionally treated with an 8% arginine-calcium carbonate paste had a statistically significant reduction in dentinal hypersensitivity one month after the application over subjects treated with a 1.23% NaF gel.

Several recent papers report the positive effect of arginine-based toothpastes in controlling dental hypersensitivity. A 100-subject, 24-week randomized clinical trial evaluated the use of an in-office 8% arginine desensitizing paste, followed by daily use of an arginine-fluoride toothpaste against a control group that had a professional polishing with a fluoride prophylaxis paste followed by a twice daily brushing with a non-densitizing toothpaste. Dentinal hypersensitivity was evaluated for subjects in both groups immediately after the professional treatment and at both 8 and 24 weeks. Test group subjects demonstrated statistically significant differences in air blast and tactile sensitivity scores. The in-office sensitivity reduction was maintained for those that used the arginine-based dentifrice twice a day.

**Additional Antimicrobial Benefits of Arginine**

Current studies indicate that arginine-calcium carbonate compounds may inhibit bacterial adhesion on tooth surfaces, reduce biofilm thickness, and reduce the density of biofilm extracellular matrix. Most recently, Burne et al. concluded that the combination of fluoride and arginine technologies produces a greater anti-caries effect than fluoride alone. The combination reduced _S. mutans_ levels and enriched _S. sanguinis_ numbers within a multispecies biofilm, while suppressing the growth of _P. gingivalis_, resulting in a healthy microbial equilibrium. Koopman et al. created an in vitro cariogenic environment and reported that arginine supplementation facilitated microbe resistance to an acidic environment, supported the stability of oral microbial communities, and suppressed the growth of _C. albicans_.

**New Products With Arginine Bicarbonate-Calcium Carbonate Technology**

Despite the well-demonstrated benefits or arginine-calcium carbonate chemistry to enhance homeostasis, until recently there have been no products directly available to consumers. In 2014, Ortek Therapeutics introduced BasicBites soft chew confections. In early 2015, Colgate launched the Sensitivity Relief Pen, a self-applied glycerin-based gel delivery system that contains...
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arginine bicarbonate calcium carbonate.

BasicBites is a sugar-free, chocolate flavored soft chew confection that contains arginine bicarbonate and calcium carbonate (the AlkaGen Technology). These key ingredients are based on Kleinberg’s® innovative research in salivary and oral microbial chemistry. They are coordinated to mimic saliva’s profound natural defenses.

Arginine is metabolized by alkali generating arginolytic bacteria in dental plaque. This can help neutralize plaque acids and facilitate an optimal neutral oral pH environment. The calcium is available to coat and support tooth structure by mass action. The bicarbonate/carbonate anions support the buffering and remineralizing activities of arginine and calcium. Laboratory studies demonstrate that BasicBites sustain and support a neutral oral pH that can last for more than 20 hours after a glucose challenge in the presence of salivary microbes.

Supplementing the oral microbiome with the arginine-bicarbonate calcium carbonate technology contained in BasicBites can be considered prebiotic therapy, since by definition, prebiotic effects occur when there is an increase in the activity of healthy microbes. The confection holds great promise for those who suffer oral disease effects from dry mouth, have a high consumption of fermentable carbohydrates or health-related, low oral pH conditions.

BasicBites chews are sweetened with maltitol, isomalt, and xylitol, contain 20 calories, deliver 20% of the calcium recommended daily amounts, are kosher and gluten free, and are available online.

The chew should be allowed to soften naturally in the mouth before chewing. Unlike sugary confections, BasicBites are designed to be chewed and retained on all tooth surfaces. BasicBites chews should be used both in the morning and at night after routine oral hygiene procedures.

CONCLUSION
Dry mouth, contemporary lifestyles, and dietary behaviors are having a dramatic impact on oral health, substantially increasing the risk for caries, erosion, dental hypersensitivity and periodontal disease. The evidence continues to grow and indicate that arginine bicarbonate-calcium carbonate technologies can play a significant role in stabilizing the oral microbiome, reduce the risk for pH mediated oral conditions and diseases, and potentially reverse early stages of demineralization. Dental professionals have a professional responsibility to evaluate all risk factors contributing to oral disease and provide appropriate information and strategies to prevent, intervene, and reverse these debilitating conditions. 

References
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POST EXAMINATION QUESTIONS

1. Ninety percent of whole saliva comes from:
   a. Parotid glands.
   b. Submandibular glands.
   c. Sublingual glands.
   d. All of the above.

2. The pH of healthy resting saliva flow is in the range of:
   a. 5.2 to 5.8.
   b. 5.8 to 6.2.
   c. 6.2 to 6.8.
   d. 6.8 to 7.2.

   a. 50%.
   b. 60%.
   c. 70%.
   d. 80%.

4. Candida albicans favors a highly acidic environment.
   C albicans contributes to the overall low pH and thickness of the biomass.
   a. The first statement is true, the second is false.
   b. The first statement is false, the second is true.
   c. Both statements are true.
   d. Both statements are false.

5. Dry mouth can be a complication for the following medical disorder(s):
   a. Autoimmune disorders.
   b. Parkinson's disease.
   c. Diabetes.
   d. All of the above.

6. Long-term stimulation of salivary flow will lead to an increase in salivary buffering.
   a. True.
   b. False.

7. Several species of bacteria use urease to break down urea.
   Caries-free individuals have high levels of urease activity.
   a. The first statement is true, the second is false.
   b. The first statement is false, the second is true.
   c. Both statements are true.
   d. Both statements are false.

8. The following can impact the metabolism of arginine, resulting in a lower alkali production.
   a. Insufficient buffering.
   b. Presence of sucrose.
   c. Low pH.
   d. All of the above.
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9. Arginine metabolism by bacteria within dental plaque can moderate the biofilm pH.
   a. True.
   b. False.

10. Current studies indicate that arginine-calcium carbonate compounds may do the following:
    a. Inhibit bacterial adhesion on tooth surfaces.
    b. Reduce biofilm thickness.
    c. Reduce the density of biofilm extracellular matrix.
    d. All of the above.
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Please check the correct box for each question below.

1.  ☐ a  ☐ b  ☐ c  ☐ d  6.  ☐ True  ☐ False
2.  ☐ a  ☐ b  ☐ c  ☐ d  7.  ☐ a  ☐ b  ☐ c  ☐ d
3.  ☐ a  ☐ b  ☐ c  ☐ d  8.  ☐ a  ☐ b  ☐ c  ☐ d
4.  ☐ a  ☐ b  ☐ c  ☐ d  9.  ☐ True  ☐ False
5.  ☐ a  ☐ b  ☐ c  ☐ d  10.  ☐ a  ☐ b  ☐ c  ☐ d

PROGRAM EVALUATION FORM
Please complete the following activity evaluation questions.

Rating Scale: Excellent = 5 and Poor = 0

Course objectives were achieved.  ________
Content was useful and benefited your clinical practice.  ________
Review questions were clear and relevant to the editorial.  ________
Illustrations and photographs were clear and relevant.  ________
Written presentation was informative and concise.  ________
How much time did you spend reading the activity and completing the test?  ________
What aspect of this course was most helpful and why?  ________
What topics interest you for future Dentistry Today CE courses?  ________

Signature

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