Effect of baking soda in dentifrices on plaque removal

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ABSTRACT

Background. The prevention of dental caries and periodontal diseases targets control of dental plaque biofilm. In this context, chemical agents could represent a valuable complement to mechanical plaque control by reducing and controlling biofilm formation.

Methods. The literature on the effectiveness of different dentifrices has not, however, been carefully categorized. A lack of consensus exists among dental professionals on a recommendation for a universal dentifrice for plaque control. The authors reviewed the scientific data on the different properties of sodium bicarbonate (baking soda)–containing dentifrices and their effectiveness in plaque removal.

Results. The results of the literature search show that baking soda–containing dentifrices are ideal candidates to be considered as a universal dentifrice because baking soda is inexpensive, abundant in supply, highly biocompatible, exhibits specific antibacterial properties to oral microorganisms, has low abrasivity, and is effective in plaque biofilm removal.

Conclusions. Although some patients may benefit from desensitizing or high fluoride–containing dentifrices, those with routine needs may find using dentifrices containing baking soda and fluoride effective.

Practical Implications. Baking soda and fluoride dentifrices, therefore, may perhaps be considered as a criterion standard for patients with routine oral hygiene needs.

Key Words. Sodium bicarbonate; baking soda; dental plaque; biofilm; bacteria.

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Dental disease remains the most prevalent chronic disease in both children and adults, despite combined efforts by dental professionals, the Centers for Disease Control and Prevention, and the National Institutes of Health.[1] Both dental caries and periodontal disease are preventable for the most part, except in rare circumstances. For any disease process, primary prevention is key as it addresses the disease before it takes root. In dentistry, this is achieved through patient education, fluoride supplementation, and behavioral changes such as dietary modifications and tailoring an ideal oral hygiene regimen for the patient before the disease has commenced.[2] The American Dental Association's (ADA's) recommendation is to brush for a minimum of 2 minutes, 2 to 3 times per day, as well as to floss at least once a day—or use an interdental brush for patients with periodontal disease or dental appliances such as braces—or both.[3] In addition, the dental professional may recommend a certain type of dentifrice to fulfill the specific needs of the patient, such as for sensitive teeth or those with a high risk of developing caries. However, for the everyday patient who does not have a specific concern, the type of dentifrice is typically not emphasized. This may be due to the fact that no one dentifrice has been deemed to be the criterion standard, as the literature is unclear on which type of dentifrice is the most effective.

Modern dentifrices come in the form of a paste, gel, or powder and typically contain several components. These components include mild abrasives used to remove debris and stain, fluoride, humectants, flavoring agents, thickening agents, and detergents to induce a foaming action.[4] Most of these components, including humectants, thickening agents, and detergents, are relatively ubiquitous in all toothpastes. Furthermore, modern dentifrices are categorized into several functions: caries prevention, antitartar activity, gingivitis reduction, plaque formation reduction, remineralization induction, cosmetic effect (whitening and stain removal), antisensitivity, and specialty (xerostomia, holistic and all-natural, and so forth). Many toothpastes have multiple

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functions and claim to be effective for both caries prevention and whitening, among other functions.

Since all toothpastes with the ADA Seal of Acceptance contain fluoride, research in dentifrices has focused on other ingredients such as abrasive agents. Abrasive agents function to polish and remove plaque and stains with the aid of a toothbrush. Abrasive agents are categorized into 4 basic classes: carbonate, phosphate, silica, and other types—for example alumina-aluminum oxide, clays, and oxides.[5] One measure of the effectiveness of the abrasive agents is the hardness of a substance, as measured by the Moh hardness value of the agent compared with dentin. Dentin has a Moh hardness value of 2.0 to 2.5, while sodium bicarbonate (baking soda) has a value of 2.5, hydrated silica dioxide's value ranges from 2.5 to 5.0, and alumina's measures at 9.25.[6] In addition, a toothpaste can also be tested for its abrasivity using the radioactive dentin abrasivity (RDA) test, also known as the ADA radiotracer method. A dentifrice with a higher RDA value may indicate a greater likelihood for tooth abrasion. For example, the RDA of Crest toothpaste has a value of 106, while Colgate Total has a value of 70, and Arm & Hammer Dental Care toothpaste with 65% baking soda has a value of 35.[6] Theoretically, the harder the agent and the greater the RDA, the more abrasive and thus more effective it would be in removing plaque and staining; however, some abrasive agents have other mechanisms of action that are not purely mechanical and can contribute to their effectiveness. In addition, environmental factors such as the pH, the hardness of the toothbrush bristles, and the pressure applied may influence the abrasiveness of the agent to the tooth surface.[7]

Needless to say, not all toothpastes are equal in effectiveness, with much due to the incorporated abrasive agent. For example, hydrated silica, alumina, and calcium pyrophosphate are biologically inert and only impose a mechanical debridement action, while baking soda has been shown to aid in reduction in pathologic microbial flora and to attenuate the oral pH.[6,8,9] To understand the role of baking soda in plaque removal, one must understand the process of plaque formation and propagation.

Plaque or biofilms are multilayered accumulations of bacteria that include initial adhesion of the microbial cells to the tooth surface at the pellicle level. At this initial phase, plaque is still relatively unattached to the tooth because adhesion of the plaque to the tooth surface occurs through weak van der Waals interactions—the weak intermolecular connections driven by electrostatic and hydrophobic forces. At this stage, plaque formation is considered to be reversible; however, if left to accumulate, a stronger bond forms between the bacterial plaque and pellicle, and the cells become irreversibly bound. Reversible plaque can be easily removed using at-home oral hygiene regimens. More mature plaque often requires professional intervention.[10] This leads to the rationale that a dentifrice that allows for effective plaque removal before it becomes irreversibly bound to the tooth will establish an environment for good oral health. In fact, supragingival plaque removal has been shown to profoundly decrease the numbers of subgingival bacterial species.[11]

Baking soda has a long history and was one of the first abrasive agents to be used in commercial toothpaste. It is also one of the most multifunctional abrasives available today, with the ability to aid in caries prevention, antitartar activity, reduction in plaque, and so on. In addition, it is biocompatible, and has a Moh hardness value that is closest to dentin. Pure baking soda has a low RDA value of 7.[12] Baking soda in dentifrice is one of the most well-studied agents, with research showing that it is superior in plaque removal compared with other abrasive agents.[13] In this review article, I aim to critically evaluate the literature to assess the effectiveness of baking soda–containing dentifrices on plaque removal.

HISTORY OF BAKING SODA

Baking soda, which is also known by other names, such as *sodium bicarbonate*, *bicarbonate of soda*, *bicarb*, or *carbonic acid monosodium salt*, was recorded to be used by Europeans for the treatment of pyorrhea alveolaris in as early as 1903 and, subsequently, in the United States in 1911.[6,14] Baking soda was first recommended to be placed as a component of tooth powder by Dr. Jules Sarrazin, dean of New Orleans College of Dentistry in 1911, because of its ability to polish teeth without abrasion to the tooth or gingiva.[15] The long history of baking soda as a dentifrice agent makes it 1 of the most well-studied abrasive agents.[14] Early dentifrices containing baking soda were marketed as anti-gingivitis, able to retard calculus formation, and even for treatment of dentinal hypersensitivity.[6,16] In a watershed 2-year study of Swedish school children, baking soda with sodium fluoride in a dentifrice was shown to be just as effective for caries prevention as the professional application of 2% aqueous sodium fluoride.[17] Original combinations of baking soda dentifrice had 1 drawback—the taste was salty; however, this was later addressed through the addition of different sweeteners and flavors. The effectiveness of baking soda has been demonstrated in the literature throughout the years. Many major dentifrice manufacturers have a variation of a baking soda–containing dentifrice, thus demonstrating its ubiquitous nature as an effective component of dental hygiene.

MECHANISM OF ACTION OF BAKING SODA

Baking soda is classified with the category of dentifrice abrasives, under the carbonate type, along with calcium

ABBREVIATION KEY. **ADA:** American Dental Association. **RDA:** Radioactive dentin abrasivity.