



Stain removal and whitening by baking soda dentifrice

A review of literature

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Tooth color, especially for teeth in the maxillary anterior region, is commonly regarded as 1 of the key components in the perception of dental esthetics and personal attractiveness. The quest for whiter teeth is not a new fashion. Tooth discoloration was recognized in the literature as a dental problem more than 150 years ago, and the use of hydrogen peroxide (H_2O_2) solution to remove tooth stains can be traced back more than a century.¹ Since the introduction of at-home tooth bleaching by Haywood and Heymann,² consumers have been increasingly interested in tooth whitening. The continued demand by the public in turn has promoted advances in tooth-whitening technology, leading to a variety of peroxide-based tooth-bleaching gels and strips as well as specifically formulated whitening tooth-pastes containing peroxide or effective abrasive systems. Today, tooth whitening is recognized as an integral part of dentistry as well as a common practice in the general population.

Although the terms “tooth bleaching” and “tooth whitening” are often used interchangeably, both in the literature and clinical practice, they are technically not synonymous. Bleaching is a process involving an oxidative chemical that alters the light-absorbing or light-reflecting nature of a material structure, increasing its perception of whiteness. Therefore, bleaching, as defined by the

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ABSTRACT

Background. Tooth discoloration may be caused by intrinsic or extrinsic stains or a combination of both. There are 2 major approaches to removing the stains, including the chemical mechanism using peroxides for tooth bleaching and the mechanical mechanism using abrasives in prophylactic pastes and dentifrices to remove stains, resulting in a whitening effect. Attempts have also been made to add a low concentration of peroxides to dentifrices to enhance their abrasive cleaning to remove tooth stains.

Types of Studies Reviewed. This article provides a review of both in vitro and clinical studies on stain removal and whitening effect of dentifrices containing sodium bicarbonate (baking soda). In recent years, whitening dentifrices have become popular because of little additional effort for use, ease of availability, low cost, and accumulated evidence of clinical efficacy and safety in the literature. Advances in research and technology have led to innovative formulations of dentifrices using baking soda as the sole abrasive or a component of an abrasive system. Baking soda is biologically compatible with acid-buffering capacities, antibacterial at high concentrations, and has a relatively lower abrasivity.

Conclusions. The evidence available in the literature indicates that baking soda-based dentifrices are effective and safe for tooth stain removal and consequently whitening. A number of clinical studies have also shown that baking soda-based dentifrices are more effective in stain removal and whitening than some non-baking soda-containing dentifrices with a higher abrasivity. So far, research efforts have mainly focused on stain removal and tooth-whitening efficacy and clinical safety of baking soda dentifrices used with manual toothbrushes, with only a few studies investigating their effects using powered toothbrushes, for which further research is encouraged.

Practical Implications. As part of a daily oral hygiene practice, baking soda-based dentifrice is a desirable, alternative or additional measure for tooth stain removal and whitening.

Key Words. Baking soda; dentifrices; sodium bicarbonate; discoloration; whitening; stain.

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International Organization for Standardization, is the “removal of intrinsic or acquired discolorations of natural teeth through the use of chemicals, sometimes in combination with the application of auxiliary means.”³ In contrast, tooth whitening is the process that results in the teeth becoming whiter in perceived color, regardless of the means used. Therefore, tooth whitening can include bleaching with peroxides and mechanical approaches to remove surface stains using professionally applied abrasive prophylaxis pastes as well as tooth brushing with a whitening dentifrice. Over the last 2 decades, advances in research and technology have led to innovative formulations of whitening dentifrices, including those using sodium bicarbonate (baking soda) as the sole abrasive or as a component of an abrasive system.

In this article, I review the etiology of tooth stain, methods used for tooth whitening, and evidence in the literature on the clinical efficacy and safety of dentifrices for stain removal and whitening, with special emphasis on baking soda dentifrice formulations.

ETIOLOGY OF TOOTH STAINS AND DISCOLORATION

Tooth discoloration is caused by stains that may be intrinsic, extrinsic, or a combination of both in terms of the source.⁴⁻⁷ Extrinsic stains usually affect the entire dentition, whereas tooth discolorations caused by intrinsic stains may involve all or individual teeth. In addition, tooth discoloration can be associated with dental procedures. In general, discoloration of anterior teeth is the major reason to consider whitening.

Intrinsic tooth stains. Intrinsic tooth stains can occur to the entire dentition or an individual tooth, and they can be caused by a number of factors, including aging, systemic medications such as tetracycline, intrapulpal hemorrhage, calcific metamorphosis, pulp necrosis, and certain diseases or tooth defects. As people age, enamel becomes thinner owing to its use while dentin becomes thicker because of dentin apposition; such physiological changes of tooth structure affect optical properties of the tooth, resulting in progressive darkening of tooth color.^{6,7} In addition, enamel cracking, crazing, and wear tend to increase with the duration of use of teeth, consequently increasing the risk of cumulative extrinsic stains from food and beverages. Tetracycline was used extensively during the 1950s and 1960s for prophylactic protection and treatment of infections and was sometimes prescribed for daily intake for an extended period. It is now well known that ingested tetracycline during tooth formation is capable of causing severe, distinctive tooth discoloration. Although tetracycline is no longer used for prolonged periods during tooth formation, dentists still face the challenge of dealing with tooth discoloration in people who used it in their childhood before the recognition of its ability to cause severe tooth stains.⁷⁻⁹

Intrinsic tooth stains also may be caused by certain diseases or conditions in which chromogenic substances are deposited within the tooth structure, such as erythroblastosis fetalis, thalassemia, sickle cell anemia, and porphyria. Severe dental fluorosis, a type of enamel hypoplasia caused by excessive exposure to fluoride during tooth formation, results in defects in enamel mineralization manifested as areas of brown discoloration.⁶⁻¹³

Extrinsic tooth stains. Extrinsic tooth stains are most commonly caused by the colored components of various food and beverages, including coffee, tea, and red wine, and by the use of tobacco products. The role of acquired pellicle in tooth-surface staining has been well recognized. Extrinsic stains are located on the tooth surface and may be aggravated in areas in which the enamel is porous and rough. The structural defects in the enamel may alter optical properties of the tooth, which is consequently perceived as discolored, whereas the porous and rough surface of the defective enamel attracts extrinsic stains present in the oral cavity.

It is important to recognize that the etiology of extrinsic staining varies significantly among people and often is influenced by oral hygiene habits, diet, and lifestyle. A variety of chromogenic oral microorganisms are capable of producing pigment molecules and consequently are responsible for some tooth stains¹⁴⁻¹⁶; for example, a 2010 article reported a case of blue tooth staining that was caused by *Pseudomonas aeruginosa*, a bacterium usually implicated in chronic pulmonary infections.¹⁷

Tooth discoloration associated with dental procedures. Certain dental materials and inappropriate operating techniques can be the origin of tooth stains. Whereas the source of a stain that causes tooth discoloration is technically extrinsic, the discoloration is limited to the individual teeth restored with the dental material or those teeth that received a dental procedure.⁷ A stain related to an amalgam restoration not only is a dark metallic color but also can produce colored corrosion products over time to stain the restored tooth. It also has been reported that extended tooth bleaching with a gel of 10% carbamide peroxide caused green staining of the tooth-amalgam interface.¹⁵ For resin composite restorations, the restoration itself may become discolored with time; furthermore, microleakage, if present, attracts extrinsic stains and consequently causes tooth discoloration. Open margins allow stains to enter the interface between the restoration and the tooth structure, which consequently discolors the underlying dentin.

ABBREVIATION KEY. CPP-ACPF: Casein phosphopeptide-amorphous calcium phosphate fluoride. H₂O₂: Hydrogen peroxide. PCR: Pellicle cleaning ratio. RDA: Relative dentin abrasivity.

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