Original Article

Non-Peroxide Bleaching Materials: A Review

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Abstract

The most frequently used bleaching materials are hydrogen and carbamide peroxide materials with specific concentration and techniques. The disadvantages of these materials range of sensitivity to bone inflammation and resorption processes. Therefore, it is desirable to employ alternative natural materials with little to no negative effects on the enamel, pulp and oral mucosa. This article reviews recently developing materials like papain, bromelain, chlorine dioxide, sodium chloride and sodium bicarbonate and a combination of peroxide and natural substances. In studies employing bromelain and papain in comparison to peroxide bleaching materials, the peroxide materials evolved to show better stain removal than the natural alternatives. It is worth mentioning that the concentrations of natural materials used were 20 times lesser compared to the peroxide materials. Chlorine dioxide was found to improve bleaching efficacy by virtue of the warmth that was created on application of light , leading to dryness of teeth. This material needs further research and improvement to match its conventional alternatives in efficacy. The newer alternatives considered in this line-up are sodium chloride and sodium bicarbonate. There was no slod scientific support to back this material's efficacy to conclusively compare it against peroxide materials. Finally, combination materials including lactoperoxidase along with hydrogen and carbamide peroxide showed to increase after 8 hours of contact than the system without lactoperoxidase. It can be concluded by saying that further research is required to find better alternatives to peroxide materials with better efficacy. Nanoparticles, off late, have found extensive purpose in modern day dentistry. The application of nanoparticles in bleaching is through hydroxyapatite nanoparticles. These nanoparticles concentration dependent whitening in comparison with carbamide peroxide. Recent developments including reduced graphene oxide has also been tried as an alternative to conventional bleaching methods. This material provided significant results and prove to be promising alternatives to peroxide tooth bleaching materials. This article reviews the developments and efficacy of non-peroxide bleaching materials.

Introduction

One of the most popular aesthetic procedures is tooth whitening. dentistry. It is a more conservative choice for important teeth whitening as contrasted with other forms of therapy like crowns or laminated ceramics [(1).] It is a tried-and-true method that offers a high degree of effectiveness and satisfaction.

The two substances that are used the most frequently are carbamide peroxide and hydrogen peroxide, with specific concentrations for certain techniques. The procedure can be carried out at a clinic or at home.[(2)] Time management, quick results, and a lower risk of material management are a few benefits of in-office tooth whitening. It also does away with the discomfort that comes with wearing trays[.(3).] The disadvantage of at-home systems is that the patient must wear the trays (in this technique, the maximum recommended concentration for carbamide peroxide is a maximum 25% and for hydrogen peroxide is a maximum 9%). This technique uses lower concentrations of peroxide, which results in a lower sensitivity [(4,5).] Although the bleaching operations are generally well tolerated, some patients still experience sensitivity both during and after [6]. The proportion of patients who are sensitive fluctuates between 43% and 80% [7-9].

One theory is that hydrogen peroxide molecules are responsible for sensitivity. The oxidation of tooth colors caused by these molecules' diffusion through enamel and dentin is what causes the bleaching effect [10]. By-products of this reaction may enter the pulp chamber [11-13], which could seriously harm pulp tissue, particularly the odontoblasts that underlie dentin. Once this occurs, pro-inflammatory cytokine release may affect the pulp[14].

Due to elevated levels of RANKL and IL-1b, teeth whitening has also been linked to bone inflammation and resorption processes in addition to being aggressive to gingival tissue, even six months after the whitening procedure [15].

Therefore, it is desirable to make any effort to increase the effectiveness of tooth whitening while having little to no negative effects on the enamel, pulp, and oral mucosa and with no contraindications. In the literature, some natural alternatives to peroxide bleaching have been noted as being capable of causing an oxidative reaction and having stain removal effects without negative outcomes [16-18].

Natural products provide some assurance about biological behavior that isn't cytotoxic and has little to no negative consequences. Additionally, the organic acids found in raw fruits like lemon, sweet orange, and white grapefruit have been proven to be effective for preserving or enhancing tooth color ([19]). Therefore, it would be advantageous to develop new tooth-bleaching methods based on natural ingredients that have equivalent cosmetic outcomes and mild side effects. In place of the conventional peroxide bleaching agents, various natural substances have been proposed, including some enzymes produced from plants, such as polyphenol peroxidase, catalase, superoxide dismutase, papain, and bromelain [18,20]. Bovine milk lactoperoxidase, horse radish peroxidase, glucose oxidase, D-(+)-glucose monohydrate, and chlorine dioxide are also cited [16]. However, nothing is known or compiled about the effectiveness of these substitute bleaching chemicals.

In a recent study [21] evaluated the effectiveness of papain and bromelain as potential substitutes for conventional bleaching agents. The authors contend that these proteases can break down the protein from spots attached to the surface of the enamel, reducing them to smaller particles and thereby increasing tooth lightness.

The current study documented the technological history of non-peroxide bleaching agents and evaluated the effectiveness of natural non-peroxide bleaching agent substitutes in tooth bleaching. The premise being investigated is that non-peroxide bleaching chemicals will exhibit performance characteristics comparable to those of peroxide bleaching agents.

Bromelain and papain

In the same study [21], papain and bromelain were evaluated for their ability to remove gel stains and compared to carbamide peroxide. Although it's crucial to note that bromelain and papain were employed in a concentration 20 times lower than the peroxide-based solution, the peroxide component showed a better stain removal efficacy. As cysteine proteases, bromelain and papain undoubtedly can disassemble larger macromolecules into smaller ones. Once they stop the light from reflecting, these macromolecules start to put pressure on the system. As a result, the inter-prismatic region may readily accommodate these tiny particles, boosting light reflection off the tooth surface and producing a bleaching effect [22] A study by Ribeiro et al comparing the whitening efficacy, enamel microhardness and roughness of papain and bromelain with standard carbamide peroxide reveals that the experimental materials showed significant color change and the change was comparable to that of standard carbamide peroxide. The major advantage of these materials over regular carbamide peroxide was in the alteration of enamel surface. Papain and Bromelain showed significantly lesser change in enamel microhardness and surface roughness after bleaching than carbamide peroxide. The same study tested the biocompatibility of these materials on mouse fibroblasts. The experimental materials, papain and bromelain did not show cytotoxic effect as compared to carbamide peroxide.

Chlorine dioxide

A powerful and practical oxidizing agent, chlorine dioxide (ClO_2) is frequently used in water treatment and bleaching. Chlorine dioxide was first used in non-dental facilities in the United Kingdom, which prompted safety concerns. In vitro research revealed that 0.07% chlorine dioxide efficiently whitened teeth at a quicker pace than 35% hydrogen peroxide, despite safety concerns[26]. Chlorine dioxide (ClO_2), which was discovered and compared to hydrogen peroxide at the same concentration, was another peroxide-free substance. According to the study, this bleaching effect was connected to the dryness of teeth, which was brought on by the warmth that was created when the light was activated. Because of this, lengthy exposures did not enhance the bleaching impact [23]. This may be the cause of the initial bleaching effect. No other study examined the bleaching effects of ClO_2. Its poor effectiveness demonstrates the need for more research [23].

Sodium chloride and sodium bicarbonate

Without solid scientific support, sodium chloride and sodium bicarbonate are often utilized and promoted as bleaching agents in a variety of electronic media [24]. Research was done dissolving sodium chloride or sodium bicarbonate in vinegar to evaluate these agents' efficacy. The former greatly reduced the inherent tooth discoloration, whilst the latter showed no discernible improvement. It is still unclear how vinegar with 4% acetic acid and salt chloride work. The bleaching effect could be related to this solution's low pH level [24].

Combination of peroxide and natural substances

It was noted that the bleaching effect was boosted in trials linking the use of peroxide with natural ingredients. In one investigation, the effects of hydrogen peroxide, carbamide peroxide, and lactoperoxidase on tetracycline stains were examined [16]. The rate of bleaching was faster after 8 hours of contact with the lactoperoxidase system than it was with only carbamide peroxide [16]. According to the theory, while the lipoperoxidase causes the secondary products of carbamide peroxide's decomposition (H_2O and O_2) to specifically react with tetracycline and result in tooth bleaching, the secondary products of carbamide peroxide (H_2O and O_2) do not have a specific site on oxidative reaction (Gimeno et al., 2008). Through the microtubules, the hydrogen peroxide/lactoperoxidase system affects the enamel's surface and inside (16).It was found that the extract generated a stronger bleaching impact when compared to groups in the study that tested the addition of sweet potato extract to hydrogen peroxide [20]. The catalase and peroxidase enzymes in the sweet potato extract encourage a decrease in activation energy, speeding up the release of free radicals [20].

At the same time, the extract's damaging effects on the enamel are mitigated by the removal of these free radicals by enzymatic and non-enzymatic antioxidants. According to a recent study, the peroxidase cycle, a one-electron reduction process, may cause the creation of oxidative intermediates [14]. This would boost hydrogen peroxide's oxidative potential, resulting in an increase in free radical liberation, improving bleaching effectiveness and minimizing harmful effects on pulp cells [14].

Nanoparticles and tooth whitening

A study by Ren Shang et al[27] experimented the effectiveness of nanoparticles of hydroxyapatite in comparison to carbamide peroxide. The experimental group consists of toothpaste slurry made of hydroxyapatite nanoparticles of two different concentrations. The study results showed that the experimental nanoparticles showed significant tooth whitening comparing initial levels. This whitening was found to be concentration dependent. Also, this material showed a significantly lesser detrimental effect on enamel[27]

I-hsuan su et al experimented the effect of cobalt-tetraphenylporphyrin/reduced graphene oxide (CoTPP/RGO), a nanocomposite highly catalytic both for oxidizing and for reducing hydrogen peroxide (H_2O_2), to whiten teeth. This material had the following clinical significance. To begin with, the Co/TPP/RGO complex enables quicker healing times and better teeth whitening. Second, because the Co/TPP/RGO complex bleached D&C Red 34 at a rate and to an extent comparable to how tea and other naturally occurring substances stain teeth, it is a useful staining agent for researching numerous crucial elements of tooth whitening.

Conclusion

It appears that non-peroxide bleaching treatments alone have not been proven to be effective for dental bleaching yet, according to the research that is currently accessible. The material that is currently available, however, points to natural agents combined with peroxide as a potential improvement to tooth bleaching. The trials revealed significant heterogeneity, and additional research is required. A review of technical advancement in this field of study revealed a wide range of additional non-peroxide bleaching agents that need future study.

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