

Teeth Whitening Effectiveness of Carbamide Peroxide Gel

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ABSTRACT

The demand for whiter teeth is not only taking the social media by storm, but is also shifting the paradigm of practicing dentistry. It has also made people conscious about the importance of oral health and hygiene. A laboratory experiment was performed using the two most widely explored active pharmaceutical ingredients associated with bleaching, Hydrogen peroxide and carbamide peroxide with various approved OTC (Over The Counter) concentrations. A 6% w/v of Hydrogen peroxide gel and 6% w/w, 10% w/w and 16% w/w of carbamide peroxide gel was formulated and an intensive evaluation was conducted over a period of 14 days using 20 extracted human teeth immersed in Coffee solution (80% caffeine and 20% chicory in hot water and filtered). The extent of discoloration and its prevention was examined using a VITA classical shade guide (A1- D4). This was documented by taking pictures of the teeth after complete staining (baseline) and after application of whitening gel, in various lighting. A comparison was drawn based on the whitening effect produced by the 6% w/v Hydrogen peroxide gel to various concentrations, 6% w/w, 10% w/w and 16% w/w of carbamide peroxide gel. It was deduced that, the 6% w/v of Hydrogen peroxide gel demonstrated a whitening effect equivalent to the 16% w/w of carbamide peroxide gel. The main objective of this study was to determine the concentration of carbamide peroxide gel (known to be less cytotoxic, less corrosive and a safer alternative) demonstrating equivalent effectiveness to a minimum OTC permissible concentration, 6% Hydrogen peroxide gel. Frequency of application and duration are critical parameters that need to be taken into consideration. This article strengthens the option to use carbamide peroxide in place of Hydrogen peroxide as an active pharmaceutical ingredient. This methodical study is a conventional, economical and non-invasive method of whitening teeth.

INTRODUCTION

Over centuries people have strived to devise in numerous equipment's and techniques to obtain a whiter shade of pale. Dating back to history, two thousand to five thousand years ago, man experimented with tooth cleaning and polishing formulations which used grounded seashells, egg shells and bones as active cleansing components. The high risk of infection and safety resulted in discontinuity of such formulations. The use of charcoal, hydrated silica and calcium carbonate came to be during the industrial era wherein it was widely tried and tested for toxicity, sensitivity and efficacy. They are still common in whitening products today, either solely or as an adjunct. Recently, people are working on modifying conventional formulations associated with Hydrogen peroxide, its analogs along with strong acids and oxidizers. They are also developing innovative regimens and techniques such as Ultra Violet (UV) light activation and pre-treatments to assist the effectiveness and efficiency of formulations. The prevention and mitigation of periodontal diseases are also being addressed in teeth whitening formulations. The preliminary approach to teeth whitening is to maintain a favourable abrasive characteristic of the formulation keeping in mind demineralization of teeth and replenishing it with mineral components. An increase in polishing properties and inhibition of tarter build up on dentine also enhances luster of the teeth and prevents its decay. All these developments have spurred a great interest and demand for oral health and hygiene. Simultaneously, the society's influences and affluence have lead to consumers indulging themselves

in esthetically enhancing treatments to achieve a brighter and whiter smile [1-3].

Understanding the Technology

Tooth Cleaning and Whitening Technology can be understood by studying the types of stains and removal methods. Stains are broadly classified into two categories, extrinsic stains and intrinsic stains based on the site of occurrence of discoloration, enamel or dentin respectively [4].

Extrinsic stains/surface stains are caused by tea, coffee, red wine, smoking and diet rich in polyphenones. The mechanism responsible for this specific type of stain is the interaction of negatively charged tooth pellicle and proteins present in mouth saliva [5].

Mechanism of extrinsic discoloration are associated with attractive forces such as Van der Waal and electrostatic forces which fall under the category of long range interactions and in short range interactions, forces such as hydration, hydrophobic, dipole-dipole and hydrogen bonding are included (Figures 1 and 2).

This article specifically focuses of removal of extrinsic discoloration caused by consumption of coffee. Off white tints are indicative of intrinsic stains. Stubborn discoloration below the enamel, penetrating into the dentin. These stains are caused by Tetracycline staining, systemic, metabolic diseases and trauma (Table 1).

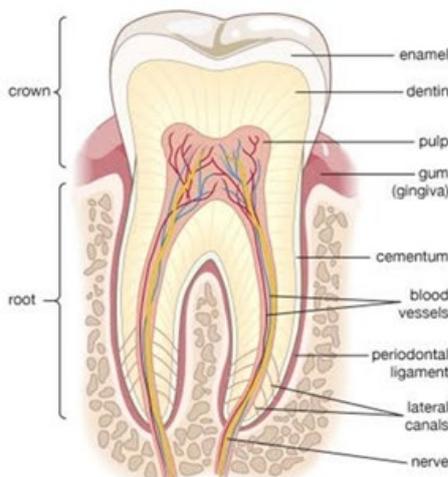


Figure 1. Illustrates the structure of the tooth as per Encyclopedia Britannica, 2013.

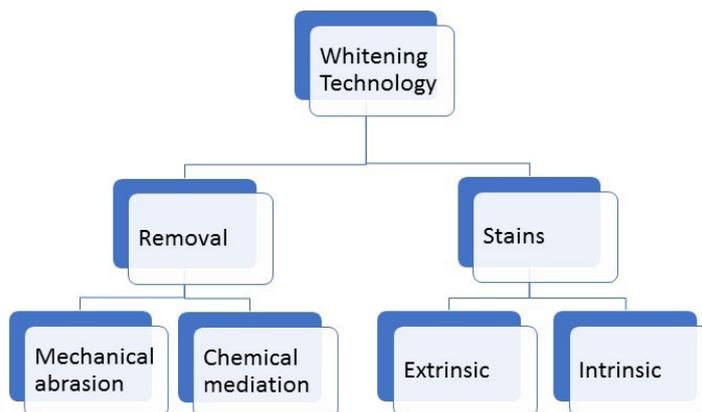


Figure 2. Demonstrates a basic classification of teeth whitening technology.

Table 1. Illustrates the understanding of the types of stains causing tooth discoloration.

| Sr. No. | Type of stain | Intrinsic | Extrinsic |
|---------|--|-----------|---------------|
| 1 | Location of discoloration | Dentin | Enamel |
| 2 | Classification based on dental discoloration | General | Nathoo type 1 |
| | | Localized | Nathoo type 2 |
| | | Chronic | Nathoo type 3 |

| | | | |
|---|-------|---|--|
| 3 | Cause | Tetracycline stains Trauma Metabolic diseases | Coffee Tea Tobacco smoking Red wine Diet containing polyphones |
|---|-------|---|--|

MATERIALS AND METHODS

Formulation and Development

Several teeth whitening options available in the market are gels, paint on liquids, strips, pastes, tray systems and rinses. This study focuses on formulating and assessing the efficacy of whitening produced by gel formulations of Hydrogen peroxide and its analog, Carbamide peroxide of different concentrations within the OTC (Over the Counter) permissible limits. Professional “at home” gels contain concentrations not more than 8% of Hydrogen peroxide and concentrations up to 21% of Carbamide peroxide. Taking into account the permissible limit, a 6% w/v of Hydrogen peroxide gel and 6% w/w, 10% w/w and 16% w/w of Carbamide peroxide gel was formulated using Carbopol 974 as a thickening agent, Clove oil as an antibacterial and flavorant and Triethanolamine as a pH adjusting agent and stabilizer ^[6-10].

Carbopol 974 was chosen for formulating the gels due to its viscosity retention property, safe compatibility with peroxides and excellent polymer cross link density that are critical to the performance of the product. Carbopol 974 NF is said to have 97% to 98% retention with 7% peroxide composition.

Clove oil was selected because it has a dual function of an antibacterial agent and a flavourant ^[7]. At first, a 2% w/w of Carbopol 974 gel base was prepared. This gel base exhibited a pH of 5 before incorporating the active pharmaceutical ingredients (Hydrogen peroxide/ Carbamide peroxide) and resulted in a very thick and stiff consistency which was not desirable.

Secondly a 0.75% w/w of Carbopol 974 gel base was prepared wherein a 6% w/v of Hydrogen peroxide solution was added and pH was adjusted to 6.7 using Triethanolamine. Clove oil was then added to impart the dual purpose of an antibacterial agent and a flavourant. This formulation was stable up to four days. However on the fifth day the gel showcased instability as its viscosity was compromised and the formulation changed color. In order to decipher the cause of the incompatibility of the excipients with the active pharmaceutical ingredient (API), in parallel a gel formulation of 6% w/v of Hydrogen peroxide was prepared without the Clove oil and this proved to be stable. An interpretation can be drawn that the Clove oil was unfavorably interacting with the Hydrogen peroxide ^[11].

Thirdly, 0.75% w/w of Carbopol 974 gel base was formulated and three different concentrations, 6% w/w, 10% w/w and 16% w/w of Carbamide peroxide were incorporated and adjusted to a pH of 6.7 with Triethanolamine and Clove Oil to impart antibacterial properties and as a flavorant. Three various concentrations of OTC permissible limit were composed to assess and evaluate their whitening efficacy in comparison to the 6% w/v of Hydrogen peroxide gel ^[12].

Evaluation of Effectiveness of Whitening Gel by Immersion in Coffee Solution

Twenty extracted human teeth were stored in formaldehyde solution just after their extraction. The teeth were assigned to five groups having four teeth in each group.

Preparation of Coffee Solution was Done by the Following Procedure

Freshly grounded coffee powder having 80% coffee and 20% chicory was taken.

Twelve grams of grounded coffee powder was added in two hundred millilitres of water and boiled.

The solution was then filtered.

The filtrate was used as a staining solution.

Five beakers were taken and 30 ml of staining solution was added to each. The first group was immersed in the solution overnight for a period of 14 days (replenishing the coloring solution each day) without application of the gels to obtain a baseline (observed to be A4 on the VITA classical shade guide) ^[13].

In case of the second group of teeth, 6% of Hydrogen peroxide gel was applied and the remaining third, fourth and fifth group, 6%, 10% and 16% Carbamide peroxide gel was applied respectively and immersed in the staining solution and kept over-

night for the same duration (14 days).

A daily evaluation was done with the help of the VITA classical shade guide by comparing the baseline (A4) with the remaining groups (Figures 3 and 4).



Figure 3. Demonstrates the whitening effect in comparison to baseline obtained.



Figure 4. Demonstrates the whitening effect in comparison to baseline obtained.

RESULTS AND DISCUSSION

The following were the observations:

6% Hydrogen peroxide gel exhibited an excellent whitening effect within the first week itself.

The baseline observed was A4 as per the VITA classical shade guide and the shade that resulted after application of the gel was found to be A1 after a one time application. This proves that the gel formulated is showcasing a preventive and whitening action against staining [14].

The 6% Carbamide peroxide gel resulted in an A3 shade after a one time application, after a week it obtained an A2 shade and remained consistent at the end of the fourteenth day. The gel showcased whitening effect however not equivalent to the 6% hydrogen peroxide gel [15-18].

10% Carbamide peroxide gel showed an A2 shade on the VITA classical shade guide after a one time application and resulted in an A1 shade after a period of five days [19,20].

16% Carbamide peroxide gel exhibited a shade of A1 after one time application. This proved to be equivalent to the 6% Hydrogen peroxide gel.

CONCLUSION

The color alterations were visually analyzed and documented. After an intensive *in vitro* evaluation of the two gels, Hydrogen

peroxide and Carbamide peroxide gel, using a VITA classical shade guide, it was observed that Hydrogen peroxide gel showed an unfavorable interaction with Clove oil and the 16% Carbamide peroxide gel showed a whitening effect equivalent to that of the 6% Hydrogen peroxide gel. However, a spectroscopic analysis and studies of drug excipient compatibility will provide a more accurate interpretation. This study strengthens the option of using the less corrosive, equally effective and safer Carbamide peroxide gel in comparison to Hydrogen peroxide gel for whitening teeth.

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