

Effectiveness and Adverse Effects of Dental Bleaching with 10-16% vs. 30-37% Carbamide Peroxide: A Systematic Review

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Abstract

Bleaching one's teeth is a less invasive alternative to getting aesthetic related work done. Although bleaching is safe when in contact with teeth and related tissues, some are still worried about its potential side effects. It is stated that the bleaching procedure must be employed according to a particular diagnostic, taking into consideration various aspects such as the following: kind of discoloration, condition of teeth produced by food, quantity of reagents used, age, kind of reactions to chemical compounds used, and time it is applied. A systematic literature review from 2012 to 2022 was performed using databases such as PubMed, Medline and ScienceDirect. The keywords used were "bleaching", "carbamide peroxide", "10% carbamide peroxide", "30% carbamide peroxide". Some studies reported 10-16% carbamide peroxide to be effective, whereas some stated otherwise. Some studies showed that using 35% CP bleaching gels had no effect on the surface roughness of composite resin. The result reveals that 10 and 16% are more effective than the 37% concentration in one week of treatment. Low concentration is enough to produced good results without the risk of any adverse effects. Both ranges of carbamide peroxide concentrations resulted in color change. However, high concentration often led to surface roughness that may support *S. mutans* deposition. Low concentration is enough to produced good results without the risk of any adverse effects.

Keywords: Bleaching, Carbamide peroxide, 10% carbamide peroxide, 30% carbamide peroxide

INTRODUCTION

In today's world, when people are more educated about their appearance and more concerned with their overall appearance, it's considered beautiful to have straight, white teeth. For those who value the aesthetics of their smile, tooth discoloration is a growing worry [1-3]. Patients who have discolored or improperly positioned front teeth generally avoid smiling because of their impact on their self-esteem. Resolving this issue will improve the patient's outward look, psychological well-being, and social interactions. As a conservative alternative to direct restorations, ceramic veneers, or enamel discoloration, bleaching teeth with antioxidants has minimal unwanted effects while improving the aesthetics in most patients [4, 5].

Bleaching one's teeth is a less invasive alternative to getting aesthetic related work done. Although bleaching is safe when in contact with teeth and related tissues, some are still worried about its potential side effects. Most people who have their teeth whitened already have some treatment on their teeth, whether a filling or a crown. Depending on the technique, teeth whitening may include chemical treatments that might harm tooth tissues and the existing restorative materials in teeth. The impact of bleaching chemicals on teeth and restoration materials has been examined in recent years. One

main worry is that composite fillings in teeth may not be as clinically durable as they otherwise would be due to the chemical softening produced by bleaching materials [6, 7].

It is stated that the bleaching procedure must be employed according to a particular diagnostic, taking into consideration various aspects such as the following: kind of discoloration, condition of teeth produced by food, quantity of reagents used, age, kind of reactions to chemical compounds used, and time it is applied. It was determined that severe damage to the pulp tissue might result from either improper tooth whitening

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procedures or the use of a very high concentration of the whitening chemical [8, 9].

MATERIALS AND METHODS

Aims of the Study

The purpose of this systematic review was to compare the efficacy and side effects of 10-16% vs. 30-37% carbamide oxide.

A systematic literature review from 2012 to 2022 was performed using databases such as PubMed, Medline and ScienceDirect. The key words used were “bleaching”, “carbamide oxide”, “10% carbamide oxide”, “30% carbamide oxide” (Table 1). PRISMA flowchart was used to describe the selection process of searched articles (Figure 1).

Table 1. Inclusion and exclusion criteria

| No | Inclusion criteria | Exclusion criteria |
|----|---|---|
| 1. | Case-control and randomized control studies | Systematic reviews or meta-analyses or expert opinions or narrative reviews |
| 2. | Published between 2012 and 2022 | Out of the specified time range |
| 3. | Studies including 10-16% and 30-37% carbamide oxide | Bleaching agent other than Carbamide oxide |

| | | |
|----|---------------------------------|-----------------------------|
| 4. | English language of publication | Language other than English |
| 7. | In vivo (humans) | In vitro |

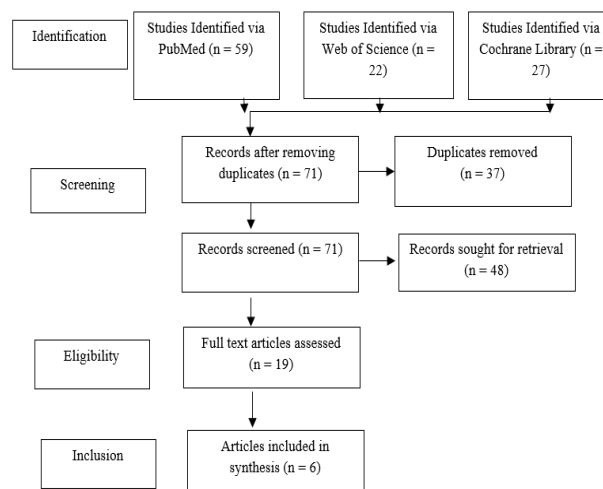


Figure 1. PRISMA Flow Diagram

Risk of Bias Assessment

Cochrane risk of bias assessment method was used to assess the quality of the studies included (Table 2).

Table 2. Summary of Cochrane Risk of Bias Assessment

| Study | Selection Bias/Appropriate control selection/baseline characteristics similarity | Selection bias in randomization | Selection bias in allocation concealment | Performance-related bias in blinding | Reporting bias/Selective reporting of outcomes | Detection bias Blinding outcome assessors | Accounting for confounding bias |
|----------------------------------|--|---------------------------------|--|--------------------------------------|--|---|---------------------------------|
| Nathan <i>et al.</i> , 2019 | + | + | + | + | + | + | - |
| Sutil <i>et al.</i> , 2022 | + | + | + | + | - | + | - |
| Anggakusuma <i>et al.</i> , 2020 | + | + | + | + | + | - | + |
| Meireles <i>et al.</i> , 2012 | + | + | + | + | + | + | - |
| Sadeghloo <i>et al.</i> , 2016 | + | - | + | + | + | + | + |
| Knezevic <i>et al.</i> , 2019 | + | + | + | - | + | + | + |

RESULTS AND DISCUSSION

The study carried out by Nathan *et al.*, analyzed the different concentrations of carbamide [10]. The result reveals that among concentration of carbamide Peroxide, 35%CP had the most peroxide leakage, followed by, 15%, and then 10% had the least. The Mann–Whitney test was used to determine between which two groups there is a statistically significant difference. When each group was compared to other groups, it was discovered that they had a statistically significant

difference. Fifty single-rooted premolars were taken from healthy young people and utilized in this study. Next, the specimens were classified into five groups, each with a similar number of large and small teeth. The amount of peroxide was calculated using an optical density reading made with a UV-visible spectrophotometer set to a wavelength of 480 nm. The current investigation found that peroxide leakage was reduced at CP 10% and 15% concentrations.

The study presented by Sutil *et al.*, chose eighty patients for clinical exams at the college's dentistry clinics [11]. Participants had to be 18 or older, in excellent general and oral health, have all of their natural teeth, be free of carious and non-carious lesions in the front area, and have no signs of periodontal disease. Gingival inflammation is a typical side effect of teeth whitening done at home. It was concluded that when 37% CP was administered, gingival inflammation would increase. However, like tooth sensitivity, gingival damage may be mitigated with shorter (37% CP) than prolonged (10% CP) usage. Finally, it is noteworthy that after three weeks of treatment, both 10% and 37% of CP displayed similar whitening benefits. The hypothesis was that the daily at-home bleaching routine would more than make up for the 10% CP gels' lower concentration. No increase in tooth sensitivity or gingival irritation was associated with using 37% CP for 30 minutes per day compared to 10% carbamide peroxide for 4 hours per day for tooth whitening. Therefore, it is possible to shorten the time you need to use the trays for at-home dental bleaching by using 37% CP for 30 minutes daily.

Another study conducted by Anggakusuma *et al.*, [12] which investigated that high quantities of *S. mutans* clung to the surface of the teeth after treatment with carbamide peroxide, as seen by turbidimetry and the TPC test. *S. mutans* was found in high quantities on the surface of the teeth after treatment with 35% carbamide peroxide (3,034,000 CFU/ml, OD: 0.06). These findings demonstrated that carbamide peroxide changed the surface structure of enamel and that enhanced the roughness which favored *S. mutans* adhesion. The surface enamel of teeth underwent structural alterations when exposed to carbamide peroxide, with more modifications seen at higher carbamide peroxide concentrations in terms of surface roughness.

Meireles *et al.*, observed the effectiveness of different carbamide peroxide concentrations (10%,16% and 37%) [13]. The result reveals that 10 and 16% are more effective than the 37% concentration in one week of treatment. At-home (10 or 16% carbamide bleaching agents) or in-office (37%) produced a similar color improvement after the end of the treatment. In comparison to the other bleaching methods evaluated within the same period, the CP37-treated group exhibited significantly lighter tooth shade averages ($p < 0.01$). One week after bleaching (T2), there was no statistically significant difference in tooth color between the CI10, CI16, and CI37 groups.

When comparing the before and after states of each treatment group's teeth, all of them became lighter (L*), less red (a*), and less yellow (b*) ($p < 0.001$). In contrast to the CP10 and CP16 groups, the CI37 group showed a smaller increase in lightness (L*) throughout both assessment windows ($p < 0.001$). At T2, there was no statistically significant difference between the CP10, CP16, CP37, and control groups in terms of a* values reduction. Compared to the other treatment groups, CI37 had a considerably smaller decline in b* values ($p < 0.001$).

The study conducted by Sadeghloo *et al.* observed the effect of 10% and 35% CP and control group on microleakage [14]. The findings indicate that there is a significant difference between the group that was bleached and the control group. The findings also show that there was no significant difference in the microleakage score between the three different concentrations of CP (10% and 35%). At a concentration of 16 percent, all ten tests (100) were resistant to the bleaching effects of carbamide peroxide. Six teeth (60%) became lighter following the second treatment. However, none of the six teeth examined showed any change in color after the third treatment (four teeth were excluded from the third process due to the unchanged shade after the first two procedures). Between the second and third treatments, we likewise observed a large and statistically significant change ($p < 0.05$). There was no noticeable improvement between the first and third bleaching procedures. 10% of teeth in a group bleached with 30% carbamide peroxide did not lighten following the first treatment. The exact binomial test demonstrated this subset's statistically significant difference ($p < 0.05$). Six teeth (86.67%) were lightened by one shade after being bleached with 16% carbamide peroxide, whereas two shades lightened only one tooth (16.67%).

The study of Knežević *et al.*, studied the use of 24 human premolars and molars that were recently removed from healthy individuals [15]. The test was used to see whether there were any statistically significant variations in microleakage scores between the groups. The results indicated that the group of teeth bleached with a higher concentration of carbamide peroxide (30%) and a shorter exposition time approximately 15 minutes achieved a greater degree of tooth color change than the group of teeth bleached with a lower concentration of carbamide peroxide (16%) and a longer exposition time (**Table 3**).

Table 3. Summary of results

| Author/year | Objectives | Material Used | Outcome |
|-----------------------------|--|---------------------------------|---|
| Nathan <i>et al.</i> , 2019 | Radicular Peroxide Penetration from Different Concentrations of Carbamide Peroxide Gel during Intracoronal Bleaching | 10%,15%,35% carbamide Peroxide. | CP (35%) most peroxide leakage than 15 and 10%. |

| | | | |
|----------------------------------|--|--|--|
| Sutil <i>et al.</i> , 2022 | Effectiveness and adverse effects of at-home dental bleaching with 37% versus 10% carbamide peroxide | 10%,37%carbamide Peroxide. | 37% CP for 30 minutes per day did not increase tooth sensitivity or gingival irritation compared to 10% CP for 4 hours per day. |
| Anggakusuma <i>et al.</i> , 2020 | Effect of carbamide peroxide on surface enamel structural changes | high quantities on the surface of the teeth after treatment with carbamide peroxide 35% (3,034,000 CFU/ml, OD: 0.06) | These findings demonstrated that carbamide peroxide changed the surface structure of enamel and that the enhanced roughness favored <i>S. mutans</i> adhesion. |
| Meireles <i>et al.</i> , 2012 | Effectiveness of different carbamide peroxide concentrations used for tooth bleaching | 10%,16%,37%carbamide Peroxide. | These findings demonstrated that carbamide peroxide 10 and 16% are more effective than the 37% concentration in one week of treatment. |
| Sadeghloo <i>et al.</i> , 2016 | Effect of various effect of different concentrations of carbamide peroxide on the marginal seal of composite | 10%,22% and 35% carbamide Peroxides | The result also shows that the concentration of CP (10%,22% and 35%) was not significant difference in microleakage score |
| Knezevic <i>et al.</i> , 2019 | The degree of tooth color change using different concentrations of carbamide peroxide | 16% and 30% carbamide peroxides | The results showed that teeth bleached with a higher concentration of carbamide peroxide (30%) and a shorter exposition period (15 minutes) had a larger degree of tooth color change. |

This review aims to assess the effects of different amounts of carbamide peroxide on tooth color. Discoloration of the teeth is a readily apparent cosmetic concern. Both patients and dentists would rather have their discolored teeth restored to their natural shade than have to resort to dental prosthetics. This concentration of CP (10%) is generally accepted as the gold standard in dentistry for at-home bleaching due to its well-documented efficacy and safety [16].

Microleakage was shown to be statistically significantly greater in the bleached group than in the unbleached group, regardless of whether 10% or 35% carbamide peroxide was used, according to the current meta-analysis. Researchers showed that bleaching chemicals had no effect on microleakage in scotch-bonded composite restorations, despite previous research suggesting that they would. Moosavi *et al.* found that non-vital bleaching with 10% CP exacerbated microleakage in the margins of composite restorations. Moosavi *et al.* discovered that microleakage in the dentin margins of composite restorations might be improved by bleaching with CP after restoration [17]. Utilization of CP has been linked to denaturation of enamel and dentin protein, both of which are embedded in inorganic compounds. Alterations to the mechanical particulars can reduce microhardness, which may cause the resin's adhesion to the teeth to deteriorate.

There are a variety of tooth bleaching treatments in the market, and their effectiveness varies depending on the concentration of carbamide peroxide they contain. The researchers used the manufacturer-recommended application method and time frame for each group to test the efficacy of carbamide peroxide- or home-use (10 and 16%). When

compared to salon-grade bleaching treatments, the results with at-home bleaching solutions (10 or 16% carbamide) are likely to be comparable. After the 37% concentration achieved its optimum efficacy, this experiment showed that contact time with the bleaching chemical was more important than gel concentration. A surprising discovery was that longer treatment times improved tooth color similarly regardless of the peroxide concentration used. Previous studies have showed that there are two key aspects to consider when selecting to whiten your teeth. Some people believe that a higher concentration of bleaching chemical in the whitening solution will yield faster and more effective effects [18]. An evaluation of 25 tooth whitening treatments and 9 clinical studies found that placing the bleaching ingredient in trays improved the success rate of dental whitening.

Teeth enamel treated with 35% carbamide peroxide revealed the most dramatic structural alterations when compared to samples treated with 10% and 15% carbamide peroxide. Carbamide peroxide induces structural changes to the enamel on the teeth's surface, as evidenced by the data, with the degree of modification indicated by the surface roughness rising with increasing carbamide peroxide concentration (up to 35 percent). Researchers Goldberg *et al.* also showed that using a stronger concentration of carbamide peroxide led to structural changes in tooth enamel [19]. However, the findings are at odds with those of previous research.

It was found that there was no statistically significant difference in the degree of tooth color change between the groups bleached with a higher carbamide peroxide concentration (30%) and shorter exposition time (two applications for a duration of 15 min each) and the group

bleached with a lower carbamide peroxide concentration (16%) and longer exposition time (four applications for a duration of 30 min each) (three applications for a duration of 30 min.). Application of the teeth-whitening solution at the optimal time was essential for optimal results. Time spent in therapy should be proportional to the extent of tooth color change for the best possible outcome. A modest concentration of a bleaching chemical applied to a tooth for a long enough time can achieve the same bleaching results as a high concentration. The time spent in contact with the bleaching chemical, rather than the gel concentration, was shown to be more important by Mireles *et al.* [13]. The teeth were successfully whitened after multiple treatments, despite the high concentration of carbamide peroxide. In this case, the authors' approach is consistent with that of the American Dental Association (ADA), which suggests using low concentrations of carbamide peroxide to whiten teeth.

Colorimetric analyses demonstrate a discrepancy between the outcomes of at-home tooth bleaching with 10% and 37% carbamide peroxide. They observed that 37% CP (30 minutes daily) was more effective than 10% CP (4 hours daily). It was expected to find that, as previous studies had demonstrated that whitening teeth after 2 weeks of usage with 15%-20% CP gels was more effective than with 10% CP gels, the results would be the same. Because it generates more free radicals, CP at higher concentrations can oxidize the substrate and induce it to react more rapidly with the organic component of dentin. However, it will take more time to attain the same amount of whitening since the lower concentration reacts with the dentin substrate more slowly, resulting in fewer free radicals.

The study indicated that 10% and 15% concentrations of CP significantly decreased peroxide leakage. This means that it may be tried instead of traditional therapies for compromised teeth with cervical dental anomalies, where the danger of external root resorption is greatest. In order to modify the walking bleach procedure, Sharafeddin and Jamalipour upped the concentration of CP to 37%. Four clinical appointments spaced out over a month were used to evaluate the tooth color. Even though it took 4 weeks to achieve the desired results (a more natural color for the teeth), it was well worth it. Ten months after treatment, a clinical and radiographic evaluation verified both the lighter tooth shade and the lack of external cervical root resorption. Sharafeddin and Jamalipour showed that using 35% CP bleaching gels had no effect on the surface roughness of composite resin [20].

Lim *et al.* found no significant difference in efficacy between 35% CP gel and 35% HP gel, two of the most frequently utilised bleaching agents [21]. 7 days later, they were far more desirable than sodium perborate. As a result, CP gel 35% was advocated as the optimal intracoronal bleaching agent, the substrate, since its higher free radical release is sufficient to initiate a faster reaction with dentin's organic component. However, since the lesser concentration reacts with the dentin substrate more slowly and so generates fewer free radicals, it

will take longer to achieve the same level of whitening. This explains why the initial degree of whitening provided by 10% CP is lower than that provided by 37% CP.

CONCLUSION

- Both ranges of carbamide peroxide concentrations resulted in color change.
- However, high concentration often led to surface roughness that may support *S. mutans* deposition.
- Low concentration is enough to produced good results without the risk of any adverse effects.

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ETHICS STATEMENT: This study fulfils the ethical requirements of Riyadh Elm University.

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