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Original Article

# The effect of different drinks on tooth color after home bleaching

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## ABSTRACT

**Objective:** This study evaluated the influence of coffee, tea, cola, and red wine staining on the color of teeth after home bleaching. **Materials and Methods:** A total of 45 samples were obtained from 45 sound maxillary central incisors. The home bleaching procedure was performed using 10% carbamide peroxide gel applied to the sample surface for a period of 6 h each day, for 14 days. After bleaching, baseline color measurements were taken, and the samples were immersed in four staining solutions (coffee, tea, cola, and red wine) or artificial saliva ($n$ = 9). Following 15 min and 6 h of immersion on the first day and next day, respectively, the samples were washed with distilled water for 10 s. After 15 min, 6 h, 1 week, and 1 month immersions, the color values of each sample were remeasured and the color change values (ΔE) were calculated. Color change analysis was performed using a spectrophotometer. The results were analyzed using analysis of variance and Tukey's honestly significant difference test ($P$ <0.05). **Results:** Of all the staining solutions, the lowest ΔE values were observed with coffee staining versus artificial saliva (control group), for all time intervals evaluated after whitening. Although no statistically differences were observed between the coffee and control group at all the time points evaluated, there were statistically significant differences between the red wine, cola, and tea solutions. **Conclusion:** Following tooth whitening, patients should avoid drinks that cause tooth staining, particularly red wine, tea and cola.

**Key words:** Bleaching, color change, spectrophotometry

## INTRODUCTION

Bleaching treatment is an effective method for restoring the color of discolored vital teeth,[1] and has been associated with peroxide concentration and bleaching time.[2] Another significant factor regarding the efficacy of bleaching techniques is patient cooperation, particularly with regard to home bleaching.[3]

The home bleaching technique, introduced by Haywood and Heyman[4] in 1989, involves selfapplication of 10% carbamide peroxide, in a customfitted plastic tray, used nightly for approximately 6 to 8 h, for a period ranging from 2 to 6 weeks. Bleaching mechanisms are based on the application of hydrogen peroxidereleasing agents. Hydrogen peroxide may be applied directly, or it may be produced from carbamide peroxide. It penetrates the tooth and produces free radicals, which then attack and break apart the chromophore bonds of large, longchain, dark colored molecules, eventually breaking these molecules down so far that they have no chromophore bonds, which results in the whitest possible teeth.[5]

Dentists advise patients to reduce the consumption of coffee and tea, and to avoid smoking or any other habit that may cause the teeth to stain, particularly after bleaching treatment, because some studies have reported that bleaching agents can alter the texture and morphology of the enamel surface.[6] There may be a loss of organic components from bleached enamel and dentin surfaces. Changes in the microstructure of teeth may be partly due to the loss or denaturing

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of protein,[7] and these alterations may facilitate the recurrence of extrinsic staining.[8] Therefore, it is significant to evaluate the effects of staining substances during and after bleaching treatment.

Certain beverages, artificial food colorings, and smoking are thought to be the most significant causes of primary coloration.[9] Studies investigating the way in which consumed staining substances can affect the results of the bleaching process after treatment are rare. Therefore, in study, we evaluated the influence of coffee, tea, cola, and red wine staining on the color of teeth after bleaching with 10% carbamide peroxide.

## MATERIALS AND METHODS

The research protocol was approved by the Clinical Research Ethical Committee of Erzurum Provincial Health Directorate. This study was carried out at the Atatürk University of Dentistry. A total of 45 sound maxillary central incisors, extracted for periodontal and several reasons a month previously, were used. Following extraction, the teeth had been stored in 8% thymol solution. Dental calculus and periodontal membrane remnants were removed using hand tools. The roots were sectioned from the dentinoenamel junction using a watercooled diamond saw (Impect PC10, Equilam Lab Equip, Brazil). Using rectangle moulds, each specimen, with the labial surface exposed, was individually submerged in chemically cured acrylic resin, through which light passes. After preparation, the samples were polished, using a prophylaxis paste administered via a polishing brush, and washed.

For the dental bleaching technique, 10% carbamide peroxide (Opalescence 10%, Ultradent Products, USA) was placed on each sample surface, using a dispenser tip, forming a layer that was 0.5 to 1 mm thick. Bleaching agent was left in contact with each tooth sample for a period of 6 h each day, and was subsequently removed using cotton and rinsing. During bleaching intervals, specimens were maintained in artificial saliva,[10] changed daily, at 37°C until further use. This procedure was repeated on a daily basis for a total of two consecutive weeks.

After bleaching, the samples were randomly divided into five groups ($n$ = 9), according to the colourant solutions: Artificial saliva (control group), red wine (DLC Öküzgözü 2009, Doluca, Turkey), coffee (Nescafe 3 in 1, Turkey; the coffee mixture was prepared by dissolving 4 g of coffee in 200 ml of boiling distilled water), cola (CocaCola, Turkey), and tea (Yellow Tea, Lipton, Turkey; the tea mixture was prepared by leaving a tea bag in 175 -ml of boiling water for 5 min). Immersion time was selected as the 15 min, 6 h, 1 week and 1 month. According to manufacturer, the average daily consumption of coffee is 15 min.[11] Therefore, 1 month immersion time for 6 h per day simulates about 24 month of drinks consumption.

The initial color values of the samples were measured 24 h after bleaching treatment, and assessed according to the CIELAB color system with a spectrophotometer (Shadepilot, DeguDent GmbH, Rodenbacher Chaussee 4, MHT Optic Research AG, 63457 Hanau, Germany) connected with a personal computer in a standardized condition. Each prepared sample was placed on the table, and the suitable mouthpart of the spectrophometer's camera was later placed at a 90 degree angle to the sample surface, which was centred in the yellow target box represented on the computer monitor. The spectrophotometer was calibrated prior to measurement of each color, with white and green ceramics provided by its makers. Following 15 min and 6 h of immersion on the first day and next day, respectively, the samples were washed with distilled water for 10 s and immersed in artificial saliva for the remainder of the day. All of the staining solutions were renewed daily. Immersion color measurements were performed after 15 min, 6 h, 1 week, and 1month. The spectrophotometric documents relating to each sample were saved by the same operator at their personal computer. All colour measurements were taken three times at different places on the middle third of each sample surface using the inbuilt synchronized image program. The color of each sample was taken as the average of three measurements, which were used for overall document analysis. The size of the circular areas used for analysis was 5 mm per sample.

Color change ($\Delta E^*_{ab}$) was calculated by the equation $\Delta E^*_{ab} = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$. When the ΔE was higher than 3.7, it was considered an easily visible difference. When it was between 3.7 and 1, it was considered a clinically acceptable difference, and when the ΔE was less than 1, the difference was considered to be not clinically visible.[12]

**Statistical analysis**

After $\Delta E^*_{ab}$ values were calculated, we performed a repeated measures analysis of variance on the results for comparison of measurements taken at four separate intervals (time factors). We then used the

*post hoc* Tukey test to determine differences among groups. Differences were considered statistically significant when $P < 0.05$.

## RESULTS

The mean ΔE values and standard deviations for all groups are represented in Table 1. For all the staining solutions, excluding artificial saliva (the control group), the lowest ΔE values were observed with the coffee solution at all time intervals evaluated after bleaching. There were no statistically significant differences in color between artificial saliva and coffee at all time intervals evaluated after bleaching, whereas significant differences were found between artificial saliva and tea, red wine, and cola solutions at all these time points.

After a 1 month immersion, the highest color difference was observed with the cola solution. Color change in the samples was easily visible difference after a 1 month immersion in artificial saliva (4.19), after a 1 week immersion in coffee solution (3.93), and after a 6 h immersion in tea (9.99), red wine (11.01), or cola (8.75) solution. Distribution of CIE L* values, CIE a* values, and CIE b values in staining solutions are shown in Figures 1-3, respectively. In red wine solution, CIE b values decreased, while these values increased with regard to the other solutions.

## DISCUSSION

A number of methods are available for evaluating tooth shade changes after bleaching, following immersion in coloring solutions. These can be classified as subjective, such as the use of a standard tooth shade guide, and objective, such as use of spectrophotometers,[13] colorimeters and computer digitization.[8] In this study, in order to achieve more consistent and accurate results, we used a spectrophotometer (shadepilot). Shadepilot allows completely accurate evaluation of spectral data, unaffected by light sources in the surgery or other ambient light.

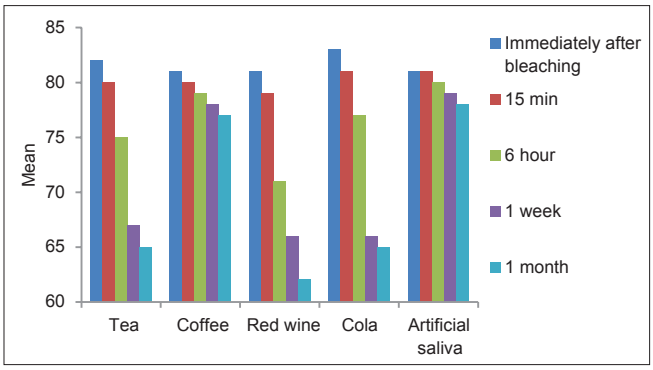


**Figure 1:** Changing CIE L* values of samples within the observation period

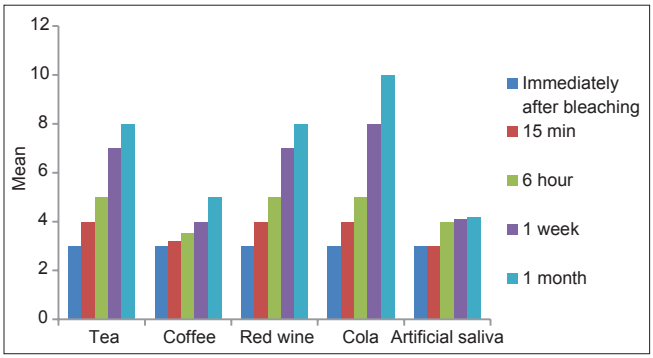


**Figure 2:** Changing CIE a* values of samples within the observation period

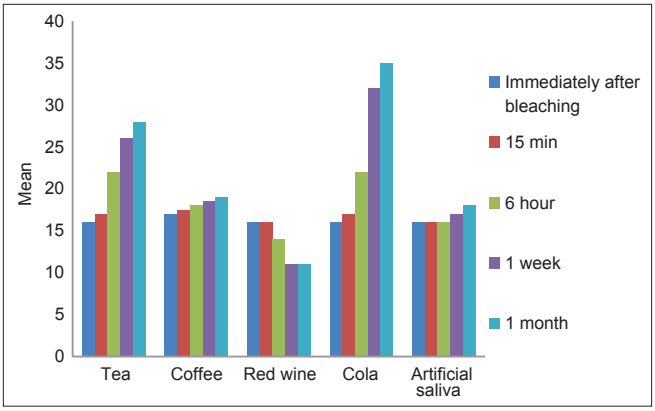


**Figure 3:** Changing CIE b* values of samples within the observation period

**Table 1: Mean ΔE values and standard deviations**

| Solution | MeanΔE (SD) | | | |
|---|---|---|---|---|
| | Time period | | | |
| | 15 min | 6 h | 1 week | 1 month |
| Tea | $^{B}$2.86 (1.48)$^{a}$ | $^{B}$9.99 (4.22)$^{b}$ | $^{BC}$18.73 (5.71)$^{c}$ | $^{B}$21.30 (6.48)$^{c}$ |
| Red wine | $^{B}$2.99 (1.81)$^{a}$ | $^{B}$11.01 (4.13)$^{b}$ | $^{B}$16.79 (5.86)$^{bc}$ | $^{B}$19.47 (6.04)$^{c}$ |
| Cola | $^{B}$2.80 (0.81)$^{a}$ | $^{B}$8.75 (4.60)$^{b}$ | $^{C}$23.84 (5.11)$^{c}$ | $^{C}$29.02 (5.97)$^{c}$ |
| Coffee | $^{AB}$2.48 (0.65)$^{a}$ | $^{A}$2.71 (1.20)$^{ab}$ | $^{A}$3.93 (1.46)$^{ab}$ | $^{A}$4.46 (1.99)$^{b}$ |
| Artificial Saliva | $^{A}$1.15 (0.38)$^{a}$ | $^{A}$1.97 (0.69)$^{ab}$ | $^{A}$3.32 (1.69)$^{bc}$ | $^{A}$4.19 (1.91)$^{c}$ |

In the same line, different superscript lowercase letters indicate statistically significant differences only among the evaluation periods in the same groups. In the same column, different superscript capital letters indicate statistically significant differences among different staining solution groups ($P$<0.05). SD: Standard deviation

The surfaces of the samples were not ground flat before the experiment, as we wanted to investigate the teeth under natural conditions. However, this might have led to a greater variation among the specimens, with respect to the adsorption of stain and the determination of the color, because of some irregularities in the surface composition of the samples. All the samples were thoroughly cleaned and polished before the experiment. This is common practice, and it is recommended that the teeth are thoroughly cleaned prior to bleaching.

We stored the samples in artificial saliva throughout the experiment, as we wanted to simulate both the remineralization of the bleached specimens[14] and the impact of saliva as being significant in the formation of tooth staining.[15,16] It is debatable as to whether microstructural defects may be repaired by remineralization.[9]

Numerous previous studies have evaluated the adverse effects of peroxidecontaining bleaching products on tooth enamel, with conflicting results. Some studies have reported no significant deleterious effects on the surface microstructure of the enamel and dentine after bleaching treatment.[17,18] However, others have actually shown a deleterious effect on the enamel and/or dentine, such as alteration of surface morphology.[19,20] Staining susceptibility cannot be related to surface roughness alone, but to enamel composition, water absorption rate, due to permeability alterations, and irregularities left on bleached enamel surfaces, which could facilitate the accumulation of dye.[20-24]

Some foods and beverages are known to cause tooth staining.[25] Some of these are acidic solutions that can increase demineralization, while others contain ethanol and pigments.[9,26] Tooth discoloration is dependent on a variety of factors, such as the pH value of the staining solution.[27] In this study, cola had the lowest pH and may have damaged the surface of the samples; it showed the highest ΔE* value 1 month and 1 week after immersion.

In view of the previously demonstrated coloring effects of staining solutions in contact with the dental structure,[28] the color stability obtained in dental bleaching should be considered as strongly linked to the dietary habits of patients, both during and after the conclusion of the bleaching process. In a previous study,[29] no significant difference was detected between photoreflectance analysis of specimens exposed to coffee solution and specimens not exposed to coffee solution after 28 days of bleaching treatment, but, when the teeth were exposed to a coffee solution during home bleaching, the whitening effect appeared to be less stable. Similarly, in our study, no statistically difference was detected between coffee and the control group at any time after bleaching.

Pini *et al*.[30] found statistically significant differences between teeth treated with coffee and wine after bleaching, compared to a control group. However, another study[31] demonstrated that bleached enamel was susceptible to red wine staining after bleaching procedures, whereas coffee did not interfere with the bleaching process. In this study, although no statistically differences were observed between coffee and the control group at any time, there were statistically significant differences between red wine and the control group at all time points evaluated.

In this study, with the exception of artificial saliva, coffee consistently showed the lowest ΔE* value at all times evaluated. At 6 h after being immersed in tea, red wine or cola, at 1 week after immersion in coffee and at 1 month after immersion in artificial saliva, color change values were greater than 3.7. Coffee and tea contain yellow colorants that have different polarities, which may explain the discoloration of the composite samples observed after immersion in tea or coffee.[32] Our results showed that tea and coffee caused different discoloration. We also found that b* values decreased over time in red wine, due to the presence blue pigments, although they increased over time in cola, coffee, artificial saliva, and tea.

## CONCLUSION

On the basis of the experimental conditions in this study, and within the limitations of an *in vitro* investigation after bleaching, we drew the following conclusions:

- Although we observed no statistically differences between coffee and the control group at any time evaluated, we found statistically significant differences between red wine, cola, tea, and the control group for all evaluated time points
- Red wine, cola, and tea caused more staining than coffee
- The cola showed the highest ΔE* value after a 1-month and a 1-week immersion
- After being immersed in tea, red wine, and cola for 6 h, after a 1-week immersion in coffee, and after a 1-month immersion in artificial saliva, color change values were greater than 3.7.

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