Nowadays, the main concern of most people is to have attractive beautiful white smile. So that the cosmetic dentistry becomes the new topic that focuses on the improvement of the overall smile appearance. Tooth staining is a common aesthetic problem which could be due to either intrinsic or extrinsic factors. There are many approaches for improving tooth color that can be as simple as whitening tooth pastes or professional at the dentist’s office such as scaling, professional bleaching, crowns and veneers. Bleaching of teeth has become an important part of esthetic dentistry, demonstrating the most conservative esthetic solution for discolored teeth that produces safer and more acceptable outcomes in a short duration of time. There are two modalities of bleaching treatment for vital teeth, including at-home and in-office bleaching techniques. In-office bleaching technique has many advantages including, the process is totally controlled by the dentist, protection of soft tissue, avoidance of material ingestion and utilizing high concentration of bleaching products which promote faster and immediate whitening results that may improve patient satisfaction and motivations. While, at-home bleaching is considered easy and effective method of bleaching mildly discolored teeth using custom soft tray loaded with low concentration of peroxide agents worn by patient at night. Contemporary bleaching products are mainly based on hydrogen peroxide or carbamide peroxide. The mechanism by which teeth are whitened dependently on the oxidation of large chromophore molecule responsible for tooth structure discoloration. The dental structure's permeability and low molecular weight of bleaching agent provide free access of hydrogen peroxidethrough the organic matrix of toothstructure. The degradation of hydrogen peroxide results in oxygen and perhydroxyl free radicals, which then oxidize the staining molecules and break down the long chains organic molecules into short colorless chains leading to a reduction in stains of tooth. There are different methods to accelerate tooth bleaching such as light and chemical-activated bleaching agents. The main advantage of light bleaching is its ability to heat and stimulate the hydrogen peroxide, there are different types of light activation, such as light emitting diodes, plasma arc lamps, halogen lamps and lasers. In chemical bleaching the effective ingredient in most whitening products is hydrogen peroxide (HP) that may be provided as hydrogen peroxide or carbamide peroxide which is a steady complex that breaks down in contact with water to release hydrogen peroxide. Recently, an expedite method of in-office bleaching has been introduced using ultrasonic energy that result in an increased production of free radicals. Although, the widespread success of bleaching products concerning with their efficacy in whitening of teeth, there is no general agreement about possible negative effects on enamel structure. Research about the influence of peroxide-based products on the chemical and physical properties of tooth structure has been controversial. Some studies stated that there was no evident change in morphology of enamel surface following bleaching treatment. However, others
have found alterations in surface morphology, calcium loss and changes in chemical composition of enamel. Thus, this study was performed to evaluate the effect of three different in-office bleaching systems on color change and enamel micromorphology.

Aim of Study
This study was intended to evaluate and compare the effect of different in-office bleaching techniques on the color change and enamel surface micromorphology.

Null hypothesis
This study was conducted to test the null hypothesis that, the tested in-office bleaching techniques neither differ in their bleaching efficacy nor in changing the enamel micromorphology.

I. Materials and Methods
Three different types of commercially available in-office teeth bleaching materials which are; one light-activated bleaching agent (Zoom) and two chemical-activated agents (Opalescence X-tra Boost, Dash) were used in this study.

A total number of 60 human permanent incisors extracted due to periodontal diseases were obtained from Outpatient Clinic, Oral Surgery Department, Faculty of Dentistry at Mansoura University. All collected teeth were examined to be free from any cracks, defects, and caries. They were cleaned from any calculus deposits and attached periodontal tissues using ultrasonic scaler (Guilin Woodpecker, Guangxi, China) and thoroughly washed under running water.

Specimen preparation
Each tooth was transversely sectioned at the cemento-enamel junction by means of a diamond instrument (Isomet, Buehler, USA) and the root was discarded. For easy holding and to prevent any possible contamination during application of bleaching agents, each tooth was fixed in polyvinyl chloride (PVC) mounting cylinder plastic mold of 2 cm width and 1 cm height, utilizing self-polymerized acrylic resin (Acrostone, Egypt). The blocks were numbered for each group by correction pen (water proof, China) (Figure 2).

Study design
The 60 prepared specimens were divided into two groups corresponding to the test conducted on, color change test group (n=30), and the micro-morphology test group (n=30). Each group was further divided into three subgroups (n=10) according to the bleaching material used (Figure 3).

Bleaching techniques
- Zoom (Light-activated bleaching agent)
  Zoom gel was applied on the labial surface of each tooth by supplied brush in a layer thickness of 1-2 mm according to manufacture’s instructions for 3 cycles, each of them was 15 minutes. The gel was activated by using Philips Zoom speed light device that was applied for 15 minutes to the teeth for each cycle.
- Dash (Chemical-activated bleaching agent)
  The dash chemical accelerator was applied on the labial surface of each tooth followed by the dash bleaching gel.

The bleaching gel was applied in a layer of thickness 1-2 mm according to manufacturer’s instructions and remained on the teeth for 15 minutes for the three sessions for each tooth.

- Opalescence X-tra Boost (Chemical-activated bleaching agent)
  Opalescence X-tra boost bleaching gel was expressed directly onto the labial surface of each tooth; in a layer thickness of approximately 1-2 mm; according to manufacture’s instructions. Before using, syringes were joined together, dry material was introduced from its syringe into the syringe comprising the hydrogen peroxide, the produced mixing bleaching material then expressed back and forth from one syringe to another 25 times to be completely mixed. After mixing, syringes were detached and the mixture was expressed directly onto the labial surface of the teeth. Bleaching gel was remained on the teeth for 15 minutes of three sessions for each tooth.

Testing procedures
Color change measurement
The color of specimens was evaluated using a reflective spectrophotometer (Model RM200QC, X-Rite, Neuenburg, Germany). They were tested for color measurement at three times, baseline, after staining and after exposure to bleaching agents. Before each measurement, the spectrophotometer was calibrated. For each specimen, three measurements were taken and the average was recorded. The result used to compare enamel surface roughness before and after bleaching.

Micromorphological evaluation
The evaluation of the surface roughness was carried out using a non-contact optical profilometer at baseline and after bleaching, three measurements were done at the middle one third of facial enamel surface of each tooth and the average was recorded. The result used to compare enamel surface roughness before and after bleaching.

Results
The numerical data explored for normality using Shapiro-Wilk test, showed that the data fall within the normal distribution curve, then analyzed using One-Way ANOVA to detect the effect of the one variable (type of bleaching material) on enamel color change and surface micromorphology.

Enamel color change
The results of the one-way ANOVA test including mean values and standard deviation of enamel color change (ΔE) between stained and bleached samples, that there was significant difference between the mean of all tested groups (P=0.014) with the highest mean value recorded for Zoom group (31.2±5.4), followed by Dash group (25.8±9.4) and the lowest in Boost group (24.8±6.3) (Table 1, Figure 1).

The post-hoc Tukey test showed that there was a significant difference in enamel color change (ΔE) between Zoom and Dash groups (P=0.014), also significant difference between Zoom and Boost groups...
While, the Dash group showed no significant difference when compared to Boost group (P3=0.889) (Table1, Figure 1).

**Table1. Results of One–way ANOVA test showing the effect of different bleaching agents on enamel color change**

<table>
<thead>
<tr>
<th>Study groups</th>
<th>Zoom Mean±SD</th>
<th>Dash Mean±SD</th>
<th>Boost Mean±SD</th>
<th>P- VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before bleaching</td>
<td>34.6±6.4</td>
<td>33.1±12.0</td>
<td>30.0±7.1</td>
<td>0.238</td>
</tr>
<tr>
<td>After bleaching</td>
<td>31.2±5.4</td>
<td>25.8±9.4</td>
<td>24.8±6.3</td>
<td>0.011</td>
</tr>
</tbody>
</table>

**Enamel micromorphology**

In addition, the results of the one–way ANOVA test, including mean values and standard deviation of enamel surface roughness after bleaching of three tested groups, that there was no statistical significant difference between the mean of all tested groups (Zoom, Dash, Boost) (P=0.591) (Table 2, Figure 2,3).

**Table2. Results of One–way ANOVA test showing the effect of different bleaching agents on enamel micromorphology**

<table>
<thead>
<tr>
<th>Study groups</th>
<th>Zoom Mean±SD</th>
<th>Dash Mean±SD</th>
<th>Boost Mean±SD</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before bleaching</td>
<td>5.09±0.30</td>
<td>5.08±0.2</td>
<td>5.06±0.3</td>
<td>0.626</td>
</tr>
<tr>
<td>After bleaching</td>
<td>5.13±0.04</td>
<td>5.10±0.07</td>
<td>5.13±0.09</td>
<td>0.591</td>
</tr>
</tbody>
</table>

Fig. 3 Representative three dimensional profilometric image of enamel surface roughness of dash bleaching agent group, (a) unbleached, (b) bleached

**Correlations between enamel color change (ΔE) and surface micromorphology**

The Pearson’s correlation test showed that there was no significant correlation between enamel color change and surface micromorphology.

In-office bleaching is more popular and superior to home bleaching in many ways, including dentist control, soft-tissue protection and guard against material ingestion, less treatment time, immediate results and more patient satisfaction.

The first, null hypothesis of this study, which anticipated that there will be no significant effect of different in-office bleaching techniques on color change was totally rejected. The results of this study regarding enamel color change revealed that all the tested bleaching agents were effective on tooth color whitening. This result in agreement with Russo et al., who stated that in-office bleaching system produced a more powerful bleaching effect than other bleaching system. Also, the result of color change showed that there was a significant difference in the ΔE mean value of two chemically-activated groups as compared to light-activated group. The light-activated bleaching system resulted in the highest mean value, followed by chemically-activated groups. This result may be referred to the combination of a light source with hydrogen peroxide, lead to activate hydrogen peroxide and accelerate the chemical redox reaction of the bleaching process and improved the whitening efficacy of bleaching agent.

The result of the present study in agreement with Liang et al., who compared the tooth whitening efficacy of light- and chemical-activated in-office bleaching systems and found that activation of peroxide based bleaching agents with light gives better whitening results.
The result of the present study contradicts to Almeida et al. who evaluated the effectiveness of different bleaching techniques and found that light sources did not improve in-office bleaching results. This contradiction may be due to their trial to activate chemically-activated bleaching agents by a light source where these agents were not indicated for light activation.

In addition, the results of enamel color change revealed that there was no significant difference between two chemically-activated bleaching agents. This result may be attributed to that the both products have the same mode of action and time of application. This result in line with Sa et al. who stated that nosignificant in the effect of different concentrations of hydrogen peroxide on the resultant color after bleaching and advised the use of bleaching agents with lower concentrations.

The second, null hypothesis of this study, which anticipated that there will be no significant effect of in-office bleaching techniques on the enamel surface micromorphology was accepted.

Regarding, the results of surface roughness showed no significant difference in surface roughness values for all tested groups before and after bleaching. The result of the present study in agreement with Dionysopoulos et al. who studied the effect of in-office tooth bleaching on enamel surface and found that the surface roughness was not significantly increase following in-office bleaching procedure. Also, the result of the present study contradicts to Anaraki et al. who evaluated the effect of different bleaching techniques on surface roughness of enamel and found that the both techniques could increase enamel surface roughness. This contradiction may be attributed to use a different light source (diode laser) while in the present study light emitting diodes was used.

**Conclusion**

1. All tested in-office bleaching systems were effectively produced teeth whitening.

2. The light-activated bleaching system produced a pronounced whitening result than chemical-activated bleaching system.

3. All tested bleaching systems did not alter enamel micromorphology.

**References**


