Antimicrobial and Antifungal effects of tissue conditioners containing a photocatalyst

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Abstract

Aim: This study evaluates the Antimicrobial and Antifungal ability of a tissue conditioner containing a photocatalyst for Streptococcus mutans, Staphylococcus aureus and Candida albicans.

Methodology: The photocatalyst was mixed with tissue conditioner powders at concentrations of 20wt%. Test specimens were made by mixing the tissue conditioner powders containing a photocatalyst mixed with liquid. All the specimens were then inoculated with media containing Streptococcus mutans, Staphylococcus aureus and Candida albicans separately, were irradiated by ultraviolet light for 4 hours. Antimicrobial and Antifungal effects were evaluated by counting the Colony forming unit (CFU).

Results: Tissue conditioners containing photocatalyst but not subjected to UV radiation showed reduction in the CFU values of 152x10^2 CFU/ml for streptococcus mutans, 164x10^2 CFU/ml for staphylococcus aureus and 154x10^2 CFU/ml for candida albicans. Tissue conditioners containing photocatalyst subjected to UV radiation show reduction in the CFU values of 97x10^2 CFU/ml for streptococcus mutans, 84x10^2 CFU/ml for staphylococcus aureus and 128x10^2 for Candida albicans.

Conclusion: Tissue conditioners containing photocatalyst irradiated with ultraviolet light controlled both bacterial and fungal growth.

Keywords: Antimicrobial effect, Antifungal effect, Tissue conditioner, Photocatalyst

Introduction:

Tissue conditioners are routinely used in prosthodontic practice to improve the condition of abused denture-bearing tissues. These materials degenerate with time and are susceptible to colonization by microorganisms. Microorganisms may cause denture stomatitis which is a matter of concern in elderly patients. In due course of time the surface of the tissue conditioner gets rough and it is difficult to clean this rough surface through mechanical and chemical methods. Incorporation of a photocatalyst to the tissue conditioners can prevent or control the colonisation of the microorganisms when the material is irradiated with Ultraviolet light. Radicals are generated in response to irradiation of photocatalyst with ultraviolet light. These radicals oxidize organic substances of micro organisms into water and carbon dioxide. This study was designed to evaluate the antimicrobial and antifungal effect of a tissue conditioner containing a photocatalyst.

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Objective:
To find out the antibacterial and antifungal effect of tissue conditioner containing a photocatalyst-titanium dioxide which is irradiated by ultraviolet radiation.

Materials and methods:
Test specimens were prepared by incorporating 1.92 g of the titanium dioxide (photocatalyst) powder to 7.68 g of tissue conditioner powder (G.C. Soft liner). The photocatalyst-tissue conditioner mixture was then mixed with 8 ml of liquid. This resulted in a concentration of 20 wt% of titanium dioxide. Nine test specimens of size 10x10x4 mm were made and divided into three groups.

Group 1 consisted of three specimens which were made by incorporating titanium di-oxide (20 wt%) into tissue conditioner (Fig. 1) and was subjected to Ultra Violet radiation of wavelength 362 nm (Fig. 2) for 4 hours.

Group 2 consisted of three specimens which were made by incorporating titanium di-oxide (20 wt%) into tissue conditioner and which were not subjected to UV radiation.

Group 3 also consisted of three specimens which were made by using tissue conditioner without incorporating titanium dioxide (Fig. 3) but were subjected to U V radiation. These specimens served as control.

Table 1: Colony Forming Unit values of specimens

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (CFU/ml)</th>
<th>Group 2 (CFU/ml)</th>
<th>Group 3 (CFU/ml)</th>
</tr>
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<tbody>
<tr>
<td>Streptococcus mutans</td>
<td>97x10^2</td>
<td>152x10^2</td>
<td>278x10^2</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>84x10^3</td>
<td>164x10^3</td>
<td>292x10^3</td>
</tr>
<tr>
<td>Candida albicans</td>
<td>128x10^2</td>
<td>154x10^2</td>
<td>201x10^2</td>
</tr>
</tbody>
</table>

Fig 1. Tissue conditioner with TiO₂
Fig 2. UV radiation chamber
Fig 3. Tissue conditioner
Fig 4. Brain – heart infusion agar
Fig 5. Tryptone – yeast extract agar
Fig 6. Sabourauds agar
Fig 7. Culture media
Streptococcus mutans was cultured anaerobically on brain heart infusion broth agar plates (Fig. 4), Staphylococcus aureus was cultured on tryptone-yeast extract medium agar plates (Fig. 5) and Candida albicans was cultured on Sabourauds agar plates (Fig. 6). Cultured organisms were then inoculated on to the specimens. The incubation period of Streptococcus mutans and Staphylococcus aureus was 32 hours. The incubation period of Candida albicans was 48 hours. Group 1 and Group 3 specimens were subjected to UV irradiation for 4 hours. The Colony Forming Units (CFU) were counted on agar plates (Fig. 7) after 48 hours for Streptococcus mutans and Staphylococcus aureus and after 72 hours for Candida albicans.

**Results:**

Tissue conditioner specimens containing photocatalyst which were not subjected to UV radiation (Group 2) showed reduction in the CFU values for all the three micro-organisms. Tissue conditioner containing photocatalyst and subjected to UV radiation showed further reduction in the CFU values for all the three micro-organisms (Group 1). Control specimens exhibited the highest CFU values (Table I).

**Discussion:**

When Titanium dioxide is irradiated with UV radiation, electron – hole pairs are generated on the photocatalyst surface\(^1\). It has been reported that the hole in the valence band has a positive redox potential and is capable of oxidizing an organic substrate adsorbed on the catalyst surface\(^4\). Hydroxyl radicals formed in the process oxidize organic substances of micro organisms into water and carbon dioxide\(^1\). The first step in the Photocatalytic attack to micro organisms is the decomposition of the cell walls\(^1\). Bacteria like Streptococcus mutans and Staphylococcus aureus are more susceptible to photocatalyst because of thin cell wall, whereas Candida albicans exhibited resistance to photocatalytic decomposition because of the thick and complex cell wall\(^1\). However in the present study Candida also showed response to the photocatalyst and UV radiation.

**Conclusion:**

Tissue conditioners containing photocatalyst irradiated with UV radiation showed antibacterial effect for streptococcus mutans and staphylococcus aureus and antifungal effect for candida albicans.

**Reference:**