Development and Antimicrobial Evaluation of Cefuroxime Axetil Loaded Chitosan Films for the Treatment of Periodontitis

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ABSTRACT SUMMARY
The aim of the present study was to formulate chitosan films containing cefuroxime axetil for the local treatment of periodontitis. The tensile strength, bioadhesion, drug release and antimicrobial studies were performed in vitro. The formulations demonstrated an initial burst release followed by a sustained release over a period of 6 hours. The formulations exhibited significant antibacterial activity against *S. aureus* and *E. coli* microorganisms. Chitosan based film formulations for cefuroxime offers a promising local drug delivery system for the treatment of periodontal diseases.

INTRODUCTION
Periodontal diseases comprise a group of inflammatory conditions of the supportive structures of the teeth [1,2]. Local delivery systems of antibacterial agents for treatment of periodontitis gained attention for the past decade since the systemic administration have its own drawbacks i.e. poor patient compliance, development of bacterial resistance and increased risk of potential side effects [3]. Cefuroxime is one of the antibacterials which is administered systemically for the therapy of periodontal diseases. Chitosan has been used widely in dental drug delivery, especially for treatment of periodontal diseases [4, 5]. It also exerts antimicrobial activity. Therefore, for local delivery of cefuroxime, chitosan based formulations would provide higher efficacy with lower dose.

EXPERIMENTAL METHODS
Films were prepared using chitosan (Sigma, USA) with medium molecular weight and 85% deacetylation degree. Cefuroxime at different concentrations (10, 15, 25 and 30% w/w) was incorporated into the formulations during preparation (solvent casting method) (Table 1). Then, the films were cross-linked using glutaraldehyde. The assay of the drug was performed on UV spectrophotometer (Shimadzu) at 281 nm. The tensile strength and bioadhesive properties of films were evaluated using a TA.XTPlus Texture Analyser (UK) equipped with Texture Exponent 4.0 Software™. Freshly obtained bovine buccal tissue was used for bioadhesion studies. The release studies were performed in Franz diffusion cells. The phosphate buffer pH 6.6 was used as the receptor medium. Antimicrobial activity was measured using disk-diffusion technique.

Table 1. Formulations prepared for studies

<table>
<thead>
<tr>
<th>Formulation Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>F-Chit</td>
<td>Plain chitosan film</td>
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<tr>
<td>F10</td>
<td>Chitosan film with 10% cefuroxime axetil</td>
</tr>
<tr>
<td>F15</td>
<td>Chitosan film with 15% cefuroxime axetil</td>
</tr>
<tr>
<td>F25</td>
<td>Chitosan film with 25% cefuroxime axetil</td>
</tr>
<tr>
<td>F30</td>
<td>Chitosan film with 30% cefuroxime axetil</td>
</tr>
<tr>
<td>F25-CL-2</td>
<td>Chitosan film with 25% cefuroxime axetil; cross-linked 2 h</td>
</tr>
<tr>
<td>F25-CL-4</td>
<td>Chitosan film with 25% cefuroxime axetil; cross-linked 4 h</td>
</tr>
<tr>
<td>F30-CL-2</td>
<td>Chitosan film with 30% cefuroxime axetil; cross-linked 2 h</td>
</tr>
<tr>
<td>F30-CL-4</td>
<td>Chitosan film with 30% cefuroxime axetil; cross-linked 4 h</td>
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</table>

RESULTS AND DISCUSSION
The prepared films were translucent and flexible with smooth surfaces. The tensile strength and work of adhesion of the formulations are shown in Fig. 1. The % elongation results indicated that the incorporation of drugs decreased the elongation at break, thus the drug-loaded films were less flexible. There were no significant difference (p > 0.05) between the uncross-linked and cross-linked films. Bioadhesion was found to decrease by cross-linking as well as drug loading.

The *in vitro* drug release results demonstrated that all the formulations had an initial burst release of drug (about 50%) in the first 2 hours (Fig. 2). The
drug release was maintained up to 6 hours. The release of cefuroxime decreased with cross-linking.

Figure 1. Tensile strength and bioadhesion properties of films

Among all the formulations, 10% w/w, 25% 30% w/w cross-linked films were selected for antibacterial studies as they possessed satisfactory physicochemical characteristics and sustained drug release profiles. The inhibition zones of formulations are shown in Fig. 3. The diameter of zone of inhibition of 10%, 25% and 30% films were found to be 42.34, 48.33 and 41.67 mm, respectively for S.aureus in 48 hours and 18.33, 12.66 and 14.00 mm, respectively for E.coli in 24 hours.

CONCLUSION

The cefuroxime loaded chitosan films demonstrated good physicochemical properties, sustained drug release and improved antibacterial efficacy against S. aureus and E. coli. The chitosan-based periodontal films for cefuroxime can be suggested as a promising delivery system for local treatment of periodontitis.

REFERENCES


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