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Production and characterization of chitosan-based thin films and hydrogel for wound healing

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Background, Motivation and Objective. The skin is the largest organ of the human body whose main function is act as a protective barrier and its rapid healing of the cutaneous lesions being of great interest, decreasing the chances of infections. In this context, this work is motivated by the high incidence of burns cases and consequently hospital infections per year in Brazil, generating excessive public spending in health area due to the slow healing lesion process. The present study aims at the development of low cost material (films and hydrogel) based on chitosan to assist in the treatment of wounds. It is intended to obtain materials that accelerates and promotes the healing process, reducing the patient's stay in hospital and public expenses.

Methods. Pure and mixed films were produced using a 1% (w/w) chitosan acetic acid aqueous solution spread at silicon plates and air-dried for 24h. Chitosan/glycerol mixed films were produced in the proportion of 10%, 30% and 50% (w/w) of glycerol. The hydrogel was produced by 3% chitosan dissolution in 10% acetic acid aqueous solution. The films were characterized by Fourier-transform infrared spectroscopy (FTIR), contact angle and thickness measurements and dynamic mechanical thermal analysis (dmta). The hydrogel will be characterized by viscosimetric analysis. The samples will be used for in vitro testing on fibroblast cell culture to assess the toxicity, proliferation, and feasibility of use in in vivo tests.

Results. Chitosan-based casting films pure and mixed with glycerol were obtained with thickness ranging from 20 µm to 35 µm (in the center) and from 25 µm to 45 µm (in the borders). The FTIR spectra, displayed in Figure 1, show the main vibrational bands for chitosan and glycerol chemical groups which were assigned as follows: at 3200-3500 cm^{-1} assigned to O-H or N-H deformation, at 2850-2970 cm^{-1} assigned to C-H, at 1645 cm^{-1} assigned to amide I group (C=O stretching), at 1550 cm^{-1} assigned to angular deformation of the CH_2 group linked to the carbonyl group, at 1585 cm^{-1} assigned to amide II band (N-H angular deformation), at 1314 cm^{-1} assigned to amide III (C=O-NH_2 axial deformation) and at 1060 cm^{-1} assigned to C-O angular deformation from chitosan. Is possible to observe that the intensity of the bands centered at 3346 and 3258 cm^{-1} (OH deformation) and the bands centered at 2923 and 2875 cm^{-1} (alkyl chains) increases as increases the glycerol percentage in the film composition. The major density of such chemical groups in the film (membrane) may facilitates the film adhesion to wounds, since the polarity of the hydroxyl groups can improves the adsorption in humid environments (wounds environment) and the hydrophobic nature of alkyl groups facilitates the adsorption on the skin.

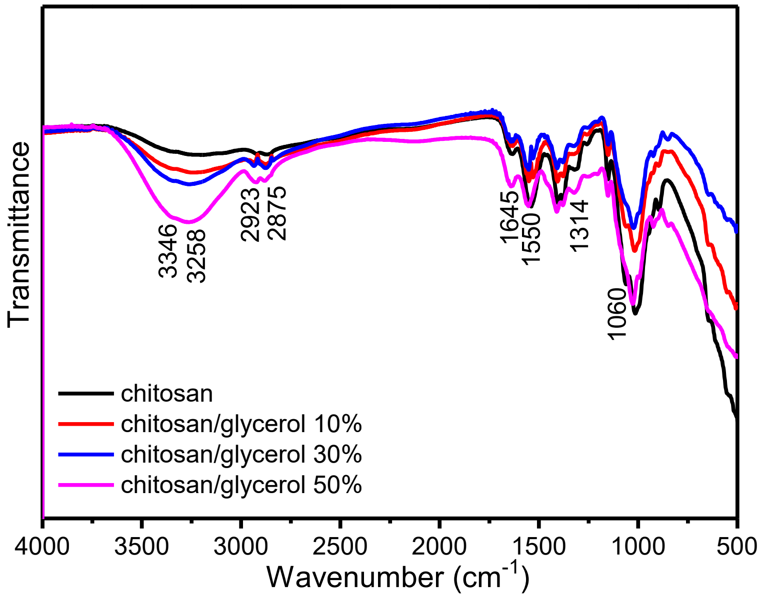

Figure 1. FTIR spectra for chitosan, chitosan/glycerol 10%, chitosan/glycerol 30% and chitosan/glycerol 50% casting films in the vibrational regions from 4000 to 500 cm^{-1}.

The wettability of the films was observed through contact angle results. A high increase in the contact angle between water and film could be seen comparing pure chitosan films (hydrophilic films) and chitosan/glycerol mixed films (hydrophobic). The angle values were found to be 35,6 ± 11,39 degrees for chitosan film, 98,2 ± 4,68 degrees for chitosan/glycerol 10% (w/w) film, 126,8 ± 1,86 for chitosan/glycerol 30% (w/w) film and 99,4 ± 0,65 for chitosan/glycerol 50% (w/w) film. Such increases are due to the alkyl chains from glycerol inserted in films matrix leading to a more hydrophobic environment. Also, the elasticity modulus measurements show higher elasticity for glycerol mixed films comparing to the pure chitosan films.

Discussion and Conclusions.

Chitosan-based sustainable casting films (membranes) were produced and characterized. The changes in the physical-chemical characteristics of the films by insertion of glycerol molecules (hydrophobicity and more elasticity) can be attributed to the hydrophobic nature of its chemical groups and to the fact that the glycerol molecules are acting as a plasticizer in the films formation (increased elasticity). Such characteristics are desirable for application on the skin aiming wound healing, leading to a production of an interesting material for in real tests (in vivo).

Keywords. Chitosan; glycerol; casting films; hydrogel; wound healing