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Bacterial nanocellulose membranes loaded with phenolic-based ionic liquids for cutaneous application

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PURPOSE OF THE ABSTRACT

In the past few years, the demand for products with anti-aging and ultraviolet (UV) protection properties has increased considerably. Preferentially, these must have in their composition natural compounds with antioxidant and anti-inflammatory activities [1]. These properties are essential to prevent and decrease skin damage. Amongst natural antioxidant compounds, phenolic compounds have gained special attention since they are naturally found in a broad diversity of plants. However, for their effective use and bioavailability, these compounds should present high solubility in aqueous solutions. One way of improving their solubility is through the modification of their chemical structure, e.g. by their conversion into salts and/or ionic liquids (ILs). On the other hand, bacterial nanocellulose (BC) is an ideal material for bioactive compounds incorporation and can be used in several biomedical applications, including transdermal drug delivery patches, wound healing membranes and skin substitutes, as well as in cosmetic products [2].

In this study, BC membranes were loaded with phenolic-based ILs with antioxidant and anti-inflammatory properties envisaging their use in cutaneous applications (Figure 1). These ionic compounds, with improved

solubility and bioavailability, were prepared by combining the cholinium cation with anions derived from caffeic, ellagic and gallic acids. All materials were characterized through Fourier transform infrared spectroscopy with attenuated total reflection (FTIR-ATR), solid nuclear magnetic resonance (NMR), X-ray diffraction, scanning electron microscopy (SEM), thermogravimetry (TGA) and mechanical tests. Then, controlled release and swelling assays were carried, followed by biological assays to evaluate their antioxidant, cytotoxicity and anti-inflammatory properties. Finally, permeation assays were performed using human skin.

The bacterial cellulose membranes loaded with phenolic-based ILs (BC-ILs) display an overall homogeneous IL distribution. The membranes are also conformable and their swelling behavior is greatly increased with the addition of ILs. BC-IL membranes in their wet state display a sustained release. BC with cholinium caffeate (BC-[Chol][Caf]) and BC with cholinium gallate (BC-[Chol][Gal]) reached maximum dissolution values of 92.03 ± 0.85 % and 100.44 ± 1.58 %, respectively.

In chemico antioxidant assays highlighted the high antioxidant activity of the wet BC-IL membranes, which was further confirmed by the in vitro antioxidant assays. In vitro assays were also performed with Raw 264.7 macrophages and HaCaT keratinocytes revealing that the novel BC-ILs membranes are non-cytotoxic and present relevant anti-inflammatory properties. Finally, diffusion studies with Hanson vertical diffusion cells allowed to demonstrate a prolonged release profile of the ILs from the BC membranes.

In summary, the prepared bioactive BC-IL membranes can be safely used for skin care and cutaneous treatment (for example burned or damaged skin). This work demonstrates the potential of BC-ILs membranes with antioxidant and anti-inflammatory properties as an innovative and biocompatible option for cutaneous application [3].

Aknowledgments

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FIGURES

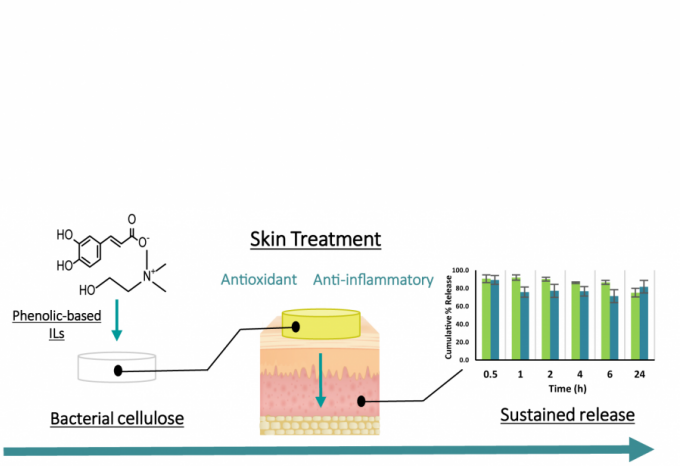

FIGURE 1

Aim of the work

Scheme depicting the purpose of the study.

FIGURE 2

KEYWORDS

Bacterial cellulose | Ionic Liquids | Phenolic Acids | Skin Treatment

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