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Development of a hydrogel with antioxidant and antibacterial properties loaded with grape pomace extracts for topical treatment of chronic wound infections

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Abstract

Background: Chronic wound infections are an emerging issue affecting millions of people globally, with profound psychological and socio-economic consequences [1]. Nonetheless, effective treatments to promote wound healing remain scarce [2]. Natural hydrogels appear as promising alternative wound dressings due to exudate absorption capacity and inherent wound-healing properties [3]. **Objective:** This study explores grape pomace (GP), the main residue of winemaking production, as a source of added-value raw material targeted for the treatment of *Staphylococcus aureus* chronic wound infections. **Methods:** Crude GP extracts (constituted by stalks or a mixture of skin and seeds from red and white grape varieties) attained using a modified solid-liquid extraction (water, ethanol, and acetone) were evaluated for their antioxidant capacity (ABTS and DPPH assays), total phenolic and total flavonoid content (TPC and TFC assay). A white GP extract was incorporated in a hydrogel composed of a chitosan-alginate matrix cross-linked by glutaraldehyde and calcium chloride. The proposed dressing was characterized by swelling, degradation, and release properties, and bioactivity was tested (antioxidant and antimicrobial activity). **Results:** Red GP extracts showed higher levels of polyphenol and flavonoid richness, but white GP extracts demonstrated superior extraction yields and antioxidant activity. Extract incorporation in the hydrogel improved its swelling and antimicrobial properties, such as bacterial membrane disruption and culturability reduction. **Conclusions:** This study resulted in a biomaterial with notable swelling and antibacterial capacity against *S. aureus*, with the potential to promote wound healing by exudate absorption and infection control. This offers alternatives for existing ineffective, side effects-laden treatments against a pathogen of clinical concern – *S. aureus*. Additionally, it contributes to the valorization of value wine production by-products, promoting a circular economy and mitigating environmental impacts.

Keywords: chronic wounds; circular economy; grape pomace extracts; hydrogel

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