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Development and Evaluation of Phycocyanin-Infused Hydrogel Topical Formulations for Wound Healing

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ABSTRACT

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The healing of wounds is a complicated biological process impaired by several factors, and conventional treatments often result in undesirable side effects. Natural compounds have emerged as favorable alternatives due to their reduced side effects. C-phycocyanin (C-Pc), a natural phycobiliprotein derived from Spirulina platensis, shows promise in wound healing but is hindered by poor stability and low bioavailability. This study aimed to develop a hydrogel-based delivery system for C-Pc to enhance its stability and therapeutic efficacy in wound healing. We synthesized a grafted gum hydrogel to encapsulate C-Pc, ensuring its sustained release. The hydrogel's physical properties, including clarity, pH, spreadability, and rheological behavior, were characterized. The encapsulation efficiency, in-vitro release profile, antioxidant activity, and adhesion were assessed. Furthermore, the hydrogel's impact on wound healing was evaluated through in-vivo studies and assessments of skin irritation potential. The optimized hydrogel demonstrated excellent physical stability, appropriate viscosity, and significant bioadhesive properties, making it suitable for topical application. The encapsulated C-Pc exhibited a controlled release, enhanced antioxidant activity, and greater wound-healing efficacy than free C-Pc. In-vivo studies confirmed accelerated wound closure with no irritation or allergy, suggesting high biocompatibility and therapeutic potential. Developing a C-Pc encapsulated hydrogel presents a promising approach to improving wound care. This innovative approach not only stabilizes C-Pc but also enhances its healing properties, providing a safe and effective option for patients. This study paves the way for a novel formulation with translatory potential.

INTRODUCTION

A wound is characterized by tissue structure and cellular connection breakdown due to various forms of injury, including physical, chemical, thermal, infections, or immune responses. The healing of wounds involves a coordinated series of cellular and biochemical reactions aimed at restoring both the structure and function of the injured tissue.^[1,2]

Several treatment choices, such as antibiotics, painkillers, and nonsteroidal anti-inflammatory drugs, are accessible for wound care, but most of these treatments come with undesirable side effects. Consequently, researchers have shifted their focus to natural compounds due to their fewer side effects. Many drugs of varying origins demonstrated significant efficacy in wound care.^[3]

C-phycocyanin (C-PC) is a water-soluble phycobiliprotein that naturally occurs in *Spirulina platensis* and is biocompatible. It has garnered significant attention for its safe and non-toxic nature. Recent studies have demonstrated various properties, including antiplatelet, wound healing properties, anti-inflammation, oxidation inhibitor, hepatoprotective, anticancer, and ability to enhance immunity. However, its therapeutic application is hindered by its short plasma half-life and instability, requiring frequent doses and leading to low patient compliance.^[3-5]

Hydrogels are intricate networks of hydrophilic polymers, able to retain significant amounts of biological fluids or water without dissolution. They present a promising option for various biomedical uses due to their ability

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