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Development of pH-Sensitive hydrogel for advanced wound Healing: Graft copolymerization of locust bean gum with acrylamide and acrylic acid

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ABSTRACT

Wounds pose a formidable challenge in healthcare, necessitating the exploration of innovative tissue-healing solutions. Traditional wound dressings exhibit drawbacks, causing tissue damage and impeding natural healing. Using a Microwave (MW)-)-assisted technique, we envisaged a novel hydrogel (Hg) scaffold to address these challenges. This hydrogel scaffold was created by synthesizing a pH-responsive crosslinked material, specifically locust bean gum-grafted-poly(acrylamide-co-acrylic acid) [LBG-g-poly(AAm-co-AAc)], to enable sustained release of c-phycocyanin (C-Pc). Synthesized LBG-g-poly(AAm-co-AAc) was fine-tuned by adjusting various synthetic parameters, including the concentration of monomers, duration of reaction, and MW irradiation intensity, to maximize the yield of crosslinked LBG grafted product and enhance encapsulation efficiency of C-Pc. Following its synthesis, LBG-g-poly(AAm-co-AAc) was thoroughly characterized using advanced techniques, like XRD, TGA, FTIR, NMR, and SEM, to analyze its structural and chemical properties. Moreover, the study examined the *in-vitro* C-Pc release profile from LBG-g-poly(AAm-co-AAc) based hydrogel (HgCPcLBG). Findings revealed that the maximum release of C-Pc (64.12 $\pm$ 2.69 %) was achieved at pH 7.4 over 48 h. Additionally, HgCPcLBG exhibited enhanced antioxidant performance and compatibility with blood. In vivo studies confirmed accelerated wound closure, and ELISA findings revealed reduced inflammatory markers (IL-6, IL-1β, TNF-α) within treated skin tissue, suggesting a positive impact on injury repair. A low-cost and eco-friendly approach for creating LBG-g-poly(AAm-co-AAc) and HgCPcLBG has been developed. This method achieved sustained release of C-Pc, which could be a significant step forward in wound care technology.

1. Introduction

Healing a wound is a complex biological process, encompassing intricate cellular and biochemical phenomena to repair the structural and functional integrity of injured tissue (Alka et al., 2023; Okur et al., 2020). This process initiates clot formation, inflammation, and cell proliferation. Neutrophils and monocytes play pivotal roles in tissue repair by combating infection and releasing growth factors to facilitate healing. Subsequently, fibroblasts and endothelial cells stimulate angiogenesis, while keratinocytes and follicular cells contribute to basement membrane reconstruction (Alka et al., 2023; Chouhan et al., 2019; Murthy et al., 2013; W. Wang et al., 2019). Despite medical advancements, chronic wounds and non-healing injuries remain a healthcare challenge.

Hydrogels (Hg) are reasonably popular in wound treatment, offering substantial water retention and promotion of a moisture-rich healing environment, resembling the extracellular matrix (ECM) found naturally in the body. With controlled biodegradability, they provide an eco-friendly solution for tissue regeneration in wound healing. Among the various types, pH-sensitive hydrogels show promise in wound healing, responding to pH changes, and offering a dynamic platform for drug delivery and effective wound management (Mamidi et al., 2019; Matar & Andac, 2021; Pettinelli et al., 2020).

This study aims to develop a pH-sensitive hydrogel to enhance

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