Design And Characterization Of Regenerative Potential In Full Thickness Burn Wound Model

Ashish Ranjan[1], Akanksha Dubey[2]

[1]*Assistant Professor, Department of Pharmacy, Kalinga University, Raipur, India.*

[2]*Assistant Professor, Department of Pharmacy, Kalinga University, Raipur, India*

KEYWORDS

Health, drugs, pharmacist, pharmaceutical care

ABSTRACT

Hydrogel is a three-dimensional network of interconnecting polymers that is crosslinked and consists of hydrophilic polymers that can absorb and endure water. Because it mimics the extracellular matrix (ECM), the hydrogel has found widespread use in pharmacological and biological applications. Many types of wound dressings are based on hydrogels due to its many advantages. These dressings include Coseal, Tegaderm, Algisite, and Evicel. Notwithstanding their exceptional ability to cure wounds, they have many drawbacks, including expensive expenses, unfavourable storage conditions, and inadequate mechanical protection for the wound. As we have come to realise the need for dressings with greater performance qualities (e.g., antimicrobial, biodegradable, responsive, and injectable), the field of wound dressings has attracted an increasing amount of interest. The purpose of this work is to evaluate the hydrogel loaded with 7, 8-Dihydroxy flavone's healing capabilities in a full-thickness burn wound model.

1. Introduction

Health systems might have to take into account how hospital-acquired problems affect critically ill patients who depend on postintensive care syndrome in the long run and how they affect their ability to recover functionally. Patients with long-standing neurological and physical disorders are known to be affected by this illness [1]. People who have burn injuries frequently don't realise that they can be affected by this kind of trauma at any time or place. Although heat from fire, hot liquids, or solids can sometimes cause injuries, the majority are brought on by friction, cold, heat, radiation, chemicals, or electric sources. Although all causes of burns entail the loss of tissue through energy transfer, there are differences in the physiological and pathological reactions linked to each cause. The main issue of skin abnormalities brought on by burns, trauma, or illness that results in skin necrosis remains unresolved despite decades of research. wound care, painful, weeps when severed, may leave scars but does not require surgery, and requires dressing [2]. Second-degree (2B) burns require surgery and scarring because the pain receptors are largely gone, which lessens pain. Because there has been damage to the nerve endings, this kind of burn usually affects the entire dermis and is painless. Unless the burn is very small, full-thickness (third degree) burns usually need to be surgically managed and protected against infection [3]. While superficial burns or burns of superficial partial thickness normally heal on their own without the need for surgery, more severe burns usually need close attention with topical antimicrobial treatments or surgery. Important burn injuries, as opposed to sepsis or trauma, for which the body heals most quickly, are marked by a systemic and local stress response following the injury. Even years after the original tissue damage, severe burns can cause a variety of intricate reactions [11]. To expedite the healing process, the inflammatory response is typically elicited right after a tissue defect. On the other hand, in cases of severe burns, this process may be widespread and uncontrollable, which could result in increased inflammation and a delayed healing response instead of a healing response itself [4]. Moreover, this hypermetabolic reaction is largely exclusive to burns; it is linked to a higher risk of infection, mortality, and organ failure. Once the extent of the burn injury has been established, the patient needs to be properly referred to and triaged. Major burn injuries have a significant influence on the patient's life as well as the carers' and families' for many years, necessitating intensive and long-term care, typically in a specialised facility. A recent study found that burn injuries had an impact on morbidity and mortality for a number of years following the injury, or at least five to ten years [5]. Thus, rather of focussing just on immediate survival, burn care practitioners must modify their objectives to give more weight to quality of life, long-term welfare, mental health, and scarring. The goal of eradicating burn wound victims' scars, agony, and mortality was taken up by trauma care specialists [6].

2. Literature Review

Bioactive polylactic acid hydrogel scaffolds (PABC) with strong antibacterial and angiogenesis capabilities can greatly enhance diabetic wound therapy [7]. The PABC scaffold has remarkable injectability, self-healing, viscoelasticity, and antibacterial properties, making it an excellent choice for wound healing applications. Not only is PABC scaffolding cytocompatible, but it also dramatically increases the angiogenic activity of EPCs in vitro. enhances angiogenesis and neovascularisation and facilitates efficient wound healing. Furthermore, the PABC scaffold promotes the growth of tissues resembling skin appendages, suggesting that our scaffold may enhance skin tissue development and lessen scarring. Injuries to the skin from combat and ordinary living are not uncommon [8]. Due to its distinct physical and chemical characteristics, silk fibroin (SF) is being utilised more often for skin wound healing. Through the creation of a moist environment, SF hydrogel effectively promotes wound healing. Through the TLN1 pathway and related proteins (paxillin, vinculin, FAS, and pFAK), it also promotes cell adhesion and migration. Based on the established roles of TLN1 in wound healing, this suggests that SF hydrogel is a suitable biomaterial for enhancing wound healing [14]. In this work, hydrogels and biomembranes are prepared using economically and biologically safe methods. Additionally, the efficacy of amnion and collagen-based hydrogels in treating rat burn wounds was studied. Lastly, a variety of factors can impact wound healing, and the specific molecular mechanisms underlying wound healing are unknown. created a hydrogel conjugated with collagen that targets EGFR, collagen, and inflammatory cells in order to cure burns [9]. Staining methods validated that hydrogel is a good extracellular matrix that promotes regenerative cell growth and is biocompatible, as indicated by cytotoxicity and proliferation assays. In studies where rats were subjected to cold restraint-induced stomach ulcers, the EGFR-H therapy proved effective in preventing the ulcers from forming. EGFR-H outperformed hydrogel alone and the control group in the in vivo experiment in terms of ulcer healing capacity and scarring reduction. By conjugating with a hydrogel, EGFR facilitates the healing of stomach ulcers brought on by cold restriction. When combined with laser therapy, a unique technique that was demonstrated by creating hydrogels as a Wound Dressing Biomaterial enhanced the healing of deep partial-thickness burn wounds and reduced scarring [10].

3. Methodology

In order to treat full thickness, burn wounds, this group generated PVA/Agar hydrogels loaded with 7, 8-dihydroxyflavone. investigations on PVA and Agar-based materials have shown benefits for wound healing; however, investigations on 7, 8-Dihydroxyflavone and burnt skin defects have not been carried out. The PVA/Agar hydrogels' physicochemical characteristics included strong hemocompatibility, swelling, and spreading abilities as well as three-dimensional linked architectures [12]. When combined with PVA/Agar hydrogel and 7, 8-Dihydroxyflavone loaded hydrogel, the wound contracted more quickly than with the negative control. In burnt skin tissue defects, 7, 8- Dihydroxyflavone loaded hydrogel therapy also dramatically enhances collagen synthesis and crosslinking. Histopathology and immunohistochemistry results showed that vascularization and macrophage polarisation were enhanced by the 7, 8-Dihydroxyflavone loaded hydrogel dressing, which sped up the healing of burnt skin wounds. In the presence of collagen, 7, 8-Dihydroxyflavone has been demonstrated to support collagen synthesis, vascularization, and tissue regeneration. Consequently, a hydrogel filled with 7, 8-dihydroxyflavone may be a useful wound dressing for full-thickness burn wounds [13].

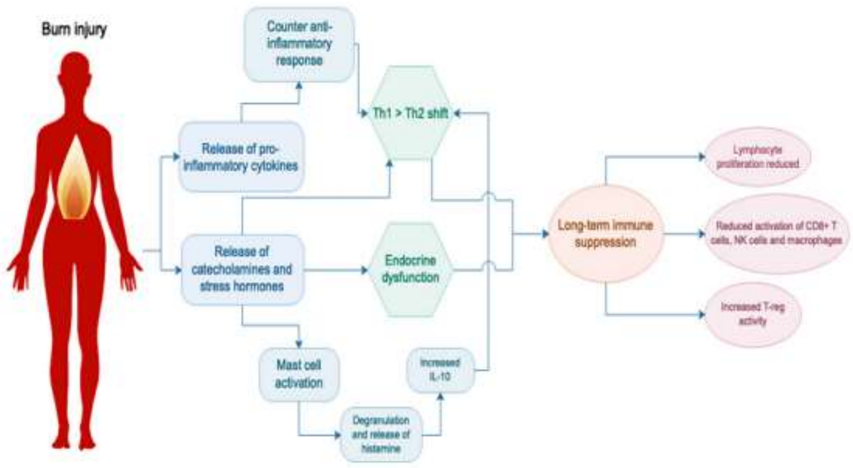

Figure 1. Significant changes of the endocrine and immune systems that occurred after burn injury

4. Results and discussion

FTIR (Fourier transform infrared) spectroscopy yielded strong evidence that 7, 8-Dihydroxyflavone was present in the hydrogel. On the other hand, O-H, C-H, C-O, and C=O functional groups were present in PVA/agar hydrogels at 3251 cm−1, 2918 cm−1, 1038 cm−1, and 1730 cm−1, respectively. Consequently, unique peaks at 3370, 1643, and 1012 cm–1 were seen in the 7, 8-Dihydroxy flavone-loaded hydrogel, which correlated with stretch bands of OH, C=O, and C-O groups. This finding suggests that during the characterisation of the hydrogel loaded with 7, 8-Dihydroxyflavone, there was a noteworthy interaction between the excipients and the 7, 8-Dihydroxyflavone. Furthermore, FTIR spectra showed that 7, 8-Dihydroxyflavone, PVA, and agar hydrogels interacted significantly to cement the scaffolds in a physiological setting.

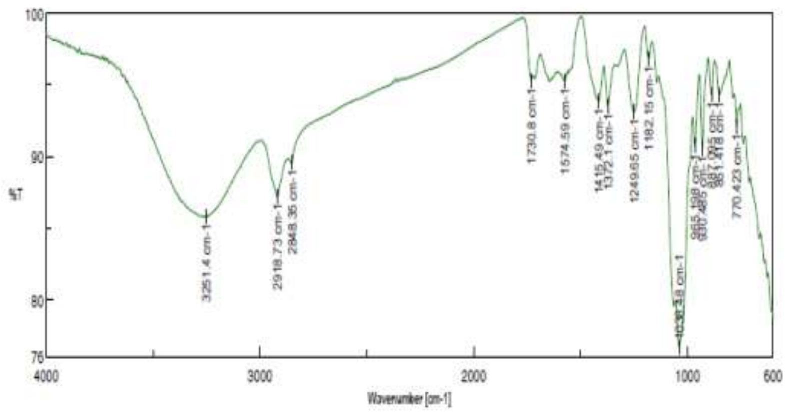

Figure 2. FTIR spectra of PVA/ Agar hydrogel

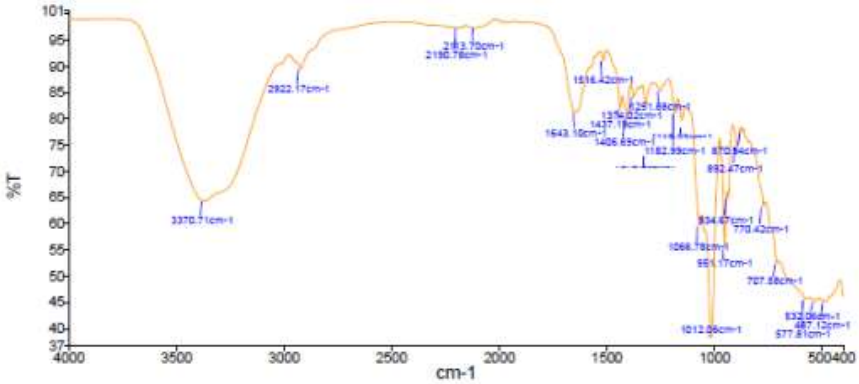

Figure 3. FTIR spectra of 7, 8-Dihydroxy flavone loaded hydrogel.

Male and female patients were included in the study. 326 patients (42.3%) and 444 male patients (57.7%) were present. This result might have happened as a result of the bulk of patients admitted during the study period being male. Another reason for this result, given that the study is being conducted in a particular region of India, could be that the female patients quit visiting the hospital after they reach a particular age.

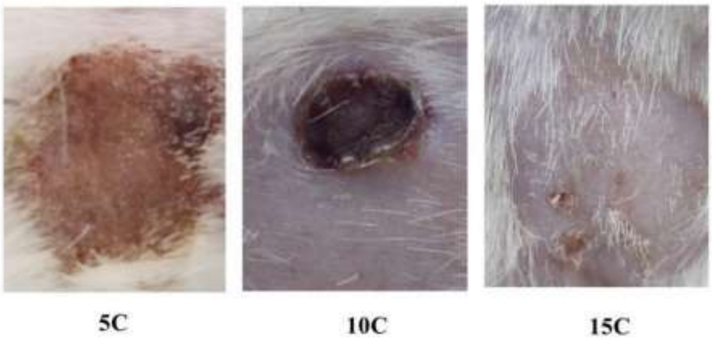

Figure 4: Invivo studies of the 7, 8 – Dihydroxy flavone loaded hydrogel treatment group on days 5, 10 and 15

Different wound healing rates were seen in the 15-day rat burn wound model after the effects of 7, 8-Dihydroxy flavone loaded hydrogel and the negative control, PVA/Agar hydrogel, were visually evaluated. Additionally, on day 15, the Wister albino rats treated with hydrogel loaded with 7, 8-Dihydroxy flavone had completely healed without scabs, outperforming the negative control rats and the PVA/Agar treated rats by a significant margin. Additionally, the assessment of the rate of wound closure revealed that on the fifth day, the 7, 8-Dihydroxy flavone demonstrated marginally improved wound healing in comparison to PVA/Agar hydrogel and negative controls. Furthermore, granular tissue development was seen on day 10 in rats administered PVA/Agar hydrogel and 7, 8-Dihydroxy flavone-loaded hydrogel. In contrast, the negative control group did not develop any granular tissue on day ten. On the fifteenth day, however, it was demonstrated that the hydrogel loaded with 7, 8-Dihydroxy flavones outperformed the PVA/Agar hydrogels in terms of epithelialisation, revascularisation, and scar-free creation. Additionally, on day 15, there was a minor bacterial contamination noted but no change in the negative control was noted.

5. Conclusion and future scope

One substance that can be utilised to create wound dressings is hydrogel. In addition to providing a physical barrier, it also extracts extra exudate and encloses a biologically active ingredient that keeps wounds moist and aids in healing. Deeply bleeding, malformed wounds can also be treated with hydrogel scaffolds. This work demonstrates that the incorporation of 7, 8-dihydroxyflavone into PVA/Agar hydrogel scaffold modulates wound healing in a beneficial way. But in addition to covering wounds and keeping them moist, the manufactured hydrogel wound dressing will aid in tissue engineering and regenerative medicine. Eventually, using these parameters, a low-cost, non-toxic PVA/Agar hydrogel delivery system containing 7, 8-Dihydroxyflavone can be created and tested in a clinical setting in the far future.

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