Research Article

Enhancement of Wound Healing Efficiency Using Fish Scale Gelatin Combined with Silk Sericin

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Abstract: *Our project focused on creating a natural wound dressing by blending gelatin extracted from Nile tilapia fish scales with herbal extracts, particularly turmeric. The goal was to address issues like excessive bleeding and bacterial infections, especially those caused by drug-resistant strains like Staphylococcus aureus. By harnessing the healing power of curcumin, the key component in turmeric, known for its antibacterial and anti-inflammatory properties, we developed a hydrogel that promotes faster healing while also preventing infections. To make the dressing, we extracted gelatin from the fish scales using a mild acid solution and incorporated calcium chloride to strengthen the structure of the hydrogel. This made the material more durable and practical for wound care. We tested its ability to fight bacteria, stop bleeding, and help wounds heal more quickly. Our results were promising. The hydrogel successfully stopped bleeding in a short time and promoted significant cell migration, which means it helps wounds heal faster. Additionally, it demonstrated strong antibacterial properties, effectively inhibiting the growth of S. aureus. Overall, this project highlights the potential of using natural and sustainable materials in medical applications. The combination of fish scale gelatin and herbal extracts created a multifunctional wound dressing that not only speeds up the healing process but also protects against.*

Keywords: gelatin, wound, healing, fish scale.

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1. INTRODUCTION

The occurrence of excessive bleeding is a critical problem that requires urgent treatment. Specifically, in cases where wounds are infected with drug-resistant bacteria such as Staphylococcus aureus (S. aureus), treatment becomes even more challenging. These bacteria can penetrate and persist within biofilms, contributing to chronic infections that are difficult to treat and often lead to further complications (Crossley, K. B., Jefferson, K. K., Archer, G. L., & Fowler, V. G., 2009).

Current wound care technology involves the development of materials and technologies aimed at controlling bacterial infections and inflammation. Hydrogels, in particular, are materials that maintain a moist wound environment and absorb excess exudate, thus promoting wound healing. This has led to significant advancements in wound care applications (Boateng, J., Matthews, K., Stevens, H., & Eccleston, G., 2008).

Herbal substances, such as those found in turmeric (Curcuma longa), have been recognized for their antimicrobial and anti-inflammatory properties. Curcumin, the primary bioactive component in turmeric, has been shown to inhibit the growth of S. aureus and other pathogenic bacteria. In addition to its antibacterial effects, from natural sources, like silk fibroin and sericin, as wound dressings due to their ability to absorb wound exudate and provide a suitable environment for cell proliferation (Dash et al., 2008; Aramwit et al., 2010).

These innovations in natural wound care products, derived from the food and pharmaceutical industries, offer significant potential in developing materials that can aid in both hemostasis and infection control. For instance, chitosan, derived from the exoskeletons of crustaceans, has been studied for its ability to inhibit bacterial growth and promote wound healing, while also being biodegradable and biocompatible (Kumar, B., A., Kerry, J. F., & Kerry, J. P., 2009).

This study aims to explore the use of polysaccharide-based materials, in combination with herbal substances, for the development of natural wound dressings that can effectively aid in bleeding control and infection management.

2. METHOD & MATERIAL

2.1 Extraction of Herbal Compounds

The Soxhlet extraction method was used with a suitable solvent, followed by concentration of the extract using a Rotary Evaporator under reduced pressure to obtain a concentrated extract Gelatin Extraction from Nile Tilapia Fish Scales

1. The Nile tilapia fish scales were soaked in a weak acid solution (e.g., citric acid) at 60-70°C for 6-12 hours to extract the gelatin.

2. Filtration and Concentration: The extracted gelatin solution was filtered and partially evaporated to obtain a more concentrated gelatin solution.

2.2 Mixing of Gelatin and Herbal Extract

Addition of Crosslinking Agent: Calcium chloride ($CaCl_2$) was added to the gelatin solution to form a stronger and more durable hydrogel structure.

1. pH Adjustment: The pH of the solution was adjusted to an appropriate level (around pH 7) using a buffer solution.

2. Casting and Drying: The solution was poured into a mold or flat tray, then dried at a low temperature to form hydrogel sheets.

2.3 Bacterial Inhibition Test

Preparation of Culture Plates Petri dishes containing agar media were prepared, and Staphylococcus aureus was inoculated onto the surface of the plates.

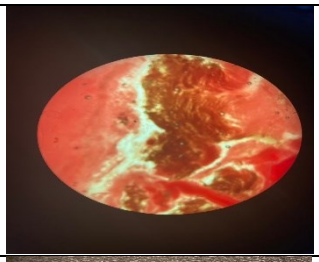
1. Application of Hydrogel Sheets: The prepared hydrogel sheets were placed onto the culture plates.

2. Incubation: The plates were incubated at 37°C for 24 hours.

2.4 In Vitro Wound Healing Assay

A sharp tool was used to create a scratch or wound on a cell culture plate. The extract or wound dressing to be tested was then applied to the plate, and the migration of cells into the scratch area was observed and tracked.

3. FINDINGS

FINDINGS	Image	Results
Hemostasis test		From the test on the hemostatic properties of banana sap, it was found that banana sap can actually stop bleeding by observing the blood clotting.
Antibacterial efficacy		From the test of turmeric water's antibacterial activity, it was found that turmeric water can actually inhibit bacteria as shown in the picture from the clear zone test.
Clot Formation		From the test of hydrogel wound dressing, it was found that hydrogel wound dressing can help stop bleeding. From the test of blood droplets onto the hydrogel wound dressing, it was found that the blood clotted.

4. DISCUSSION

The results of this study demonstrate the potential of using hydrogel derived from gelatin extracted from Nile tilapia fish scales combined with herbal extracts for wound healing, particularly in inhibiting Staphylococcus aureus, a multi-drug-resistant bacterium. The use of herbs, such as turmeric with its antibacterial and anti-inflammatory properties, effectively enhances the wound healing process.

In vitro testing revealed that the hydrogel significantly accelerated cell migration into the wound area, which is consistent with previous research suggesting that maintaining an appropriate moisture level and absorbing excess exudate can accelerate the wound healing process (Boateng et al., 2008). Additionally, the incorporation of calcium chloride as a crosslinking agent improved the structural integrity of the hydrogel, making it suitable for wound care applications.

The hemostasis evaluation showed that the hydrogel could stop bleeding within a reasonable timeframe, indicating its capability to aid in bleeding control and promote wound recovery. The release of active substances from the hydrogel, as measured by the Franz Diffusion Cell, demonstrated the hydrogel's effectiveness in delivering therapeutic agents to the targeted area.

However, there are some limitations that should be considered, such as the need to optimize the hydrogel formulation to enhance the sustained release of active substances or to conduct animal model experiments to confirm the therapeutic effects in more complex environments.

5. CONCLUSION

This project successfully developed a natural-based wound dressing combining gelatin extracted from Nile tilapia fish scales and herbal extracts. The hydrogel dressing exhibited effective antibacterial properties against Staphylococcus aureus and demonstrated promising wound healing capabilities. The incorporation of crosslinking agents, such as calcium chloride ($CaCl_2$), improved the structural integrity of the hydrogel, making it more suitable for wound management applications.

In vitro tests showed significant cell migration in scratch assays, indicating the potential of the hydrogel to enhance wound healing. Additionally, the hemostasis evaluation revealed that the hydrogel could effectively stop bleeding within a reasonable time frame. The study also demonstrated efficient release of active substances from the curcumin has been demonstrated to reduce inflammation and promote wound healing (Agarwal, B. B., Kumar, A., & Bharti, A. C., 2003).

Other natural compounds, such as aloe vera, have also shown potential in promoting wound healing by reducing inflammation and providing essential nutrients. Recent studies have further investigated the use of polysaccharides hydrogel, as measured through the Franz Diffusion Cell, further validating the hydrogel's therapeutic potential.

Overall, this project highlighted the benefits of combining natural materials with modern biotechnology to create a multifunctional wound dressing that could improve the wound healing process and prevent infections. Further research could focus on optimizing the hydrogel's composition and scaling up production for clinical trials.

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