PREPARATION AND EVALUATION OF ALGINATE SCAFFOLDS ENRICHED WITH *KIGELIA AFRICANA*

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Introduction

Chronic wounds, particularly diabetic wounds, represent a major healthcare challenge due to prolonged inflammation which impairs normal wound healing process and **increases susceptibility to bacterial infections**, leading to further complications which may **reduce patients' quality of life**. Conventional wound dressings merely act as a basic protective barrier against infection and possess limited efficacy to maintain an optimal microenvironment for wound healing. Hence, they are inadequate for chronic wound treatment, highlighting the **need for more advanced therapeutic strategies**. Alginate-based wound dressings have emerged as a promising approach owing to their **biocompatibility, biodegradability, moisture retention, and exudate absorption capabilities**. Gallium can enhance scaffold functionality by serving as both **crosslinking and antibacterial agent**; while *Kigelia africana* which is rich in phenolic compounds, was found to exhibit **excellent antioxidant and antimicrobial activities** for wound healing. Therefore, this study aimed to develop gallium crosslinked alginate-based scaffolds enriched with *Kigelia africana* as a potential multifunctional dressing for chronic wound management.

Objectives

- To prepare gallium crosslinked alginate-based scaffolds loaded with *Kigelia africana* powder via **lyophilisation**
- To evaluate the **physicochemical and biological properties** of the gallium crosslinked alginate-based scaffolds loaded with *Kigelia africana* powder

Methodology

Fabrication of scaffolds

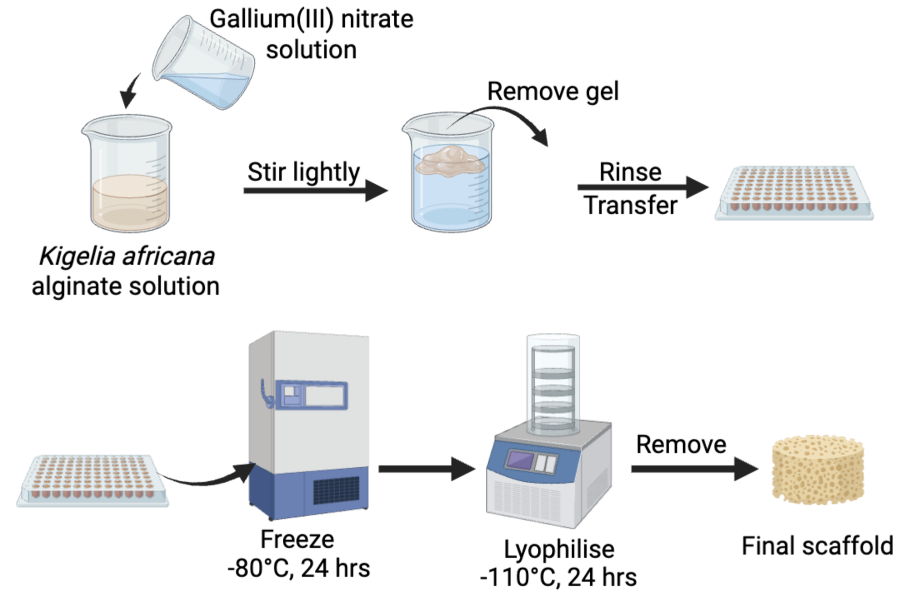

Table I: Formulation for alginate scaffolds fabrication

Sample code	NaALG (%w/v)	$Ga(NO_3)_3$ (%w/v)	K (mg)
ALG (blank)	2	0	0
GALG (control)	2	0.5	0
GALG/K-1	2	0.5	500
GALG/K-2	2	0.5	1000
GALG/K-3	2	0.5	1500
GALG/K-4	2	0.5	2000
GALG/K-5	2	0.5	2500

*ALG = Alginate; K = *Kigelia africana* powder; G = Gallium(III)

Characterisation of scaffolds

Physicochemical properties
- ATR-FTIR Analysis
- Apparent Density Measurement
- Porosity Measurement
- Swelling Analysis
- Degradation Analysis
- Gel Fraction Measurement
- *Kigelia africana* Loading Content
- *Kigelia africana* Entrapment Efficiency

Biological properties
- Antioxidant Test
- Antibacterial Test

Results

1. ATR-FTIR Spectroscopy

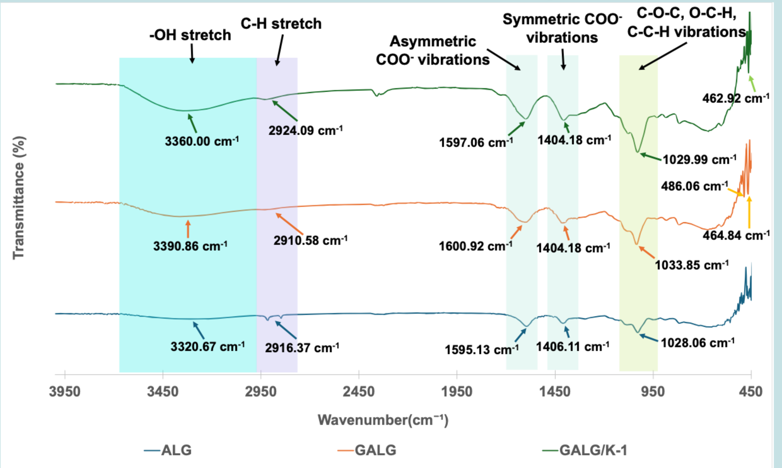

Figure 1: FTIR spectra for ALG, GALG and GALG/K-1 scaffolds over 4000 – 450 cm⁻¹.

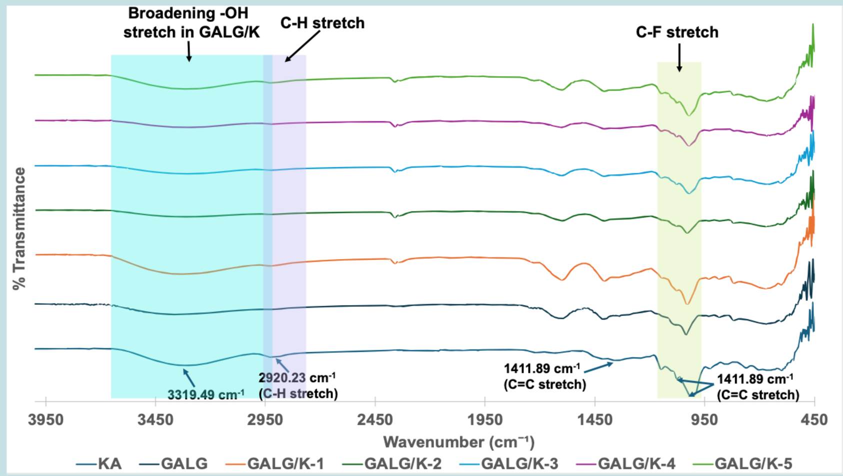

Figure 2: FTIR spectra for KA, GALG, GALG/K-1, GALG/K-2, GALG/K-3, GALG/K-4 and GALG/K-5 scaffolds over 4000-450 cm⁻¹.

2. Scanning Electron Microscopy

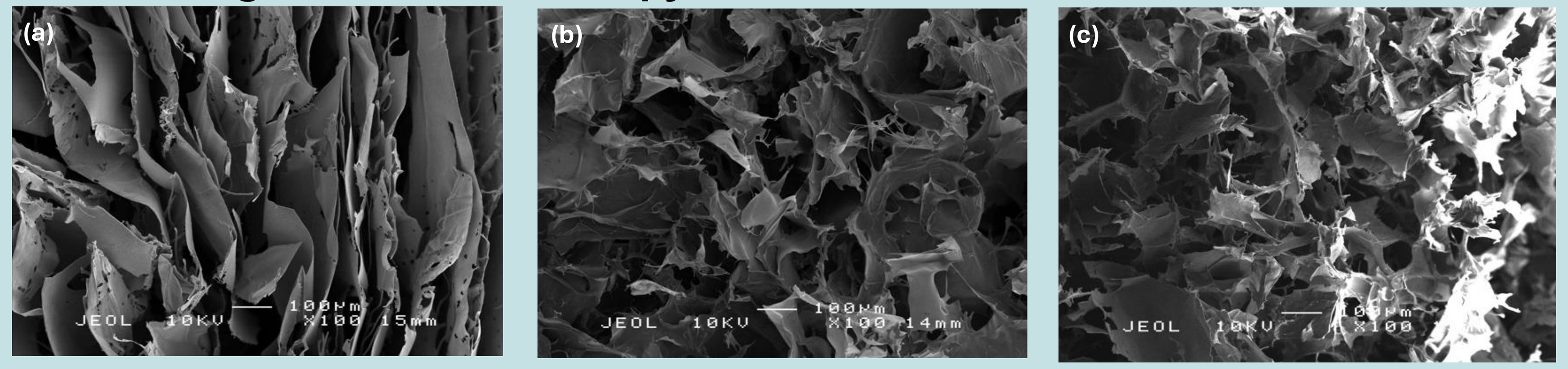

Figure 3: Surface morphology of (a) ALG , (b) GALG/K-1 and (c) GALG/K-5 scaffolds at magnification of 100×.

3. Apparent Density

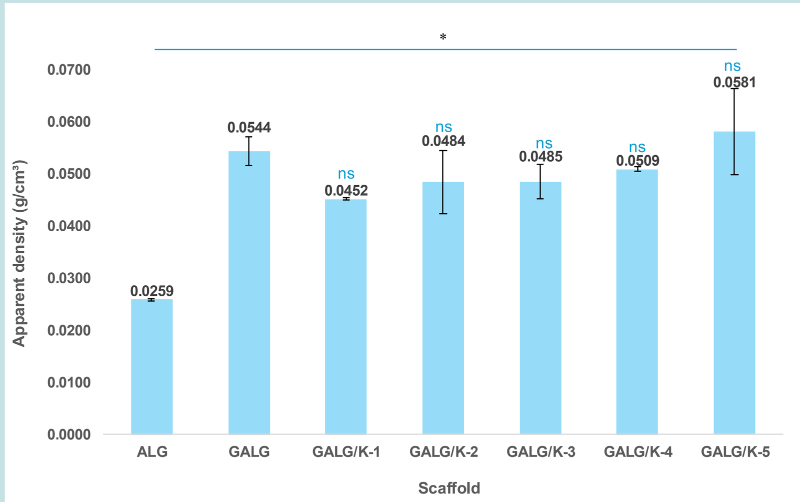

Figure 4: Comparison of Apparent Density of ALG, GALG, GALG/K-1, GALG/K-2, GALG/K-3, GALG/K-4 and GALG/K-5 scaffolds. (* indicates p<0.05; ns indicates non-significance of result)

4. Porosity

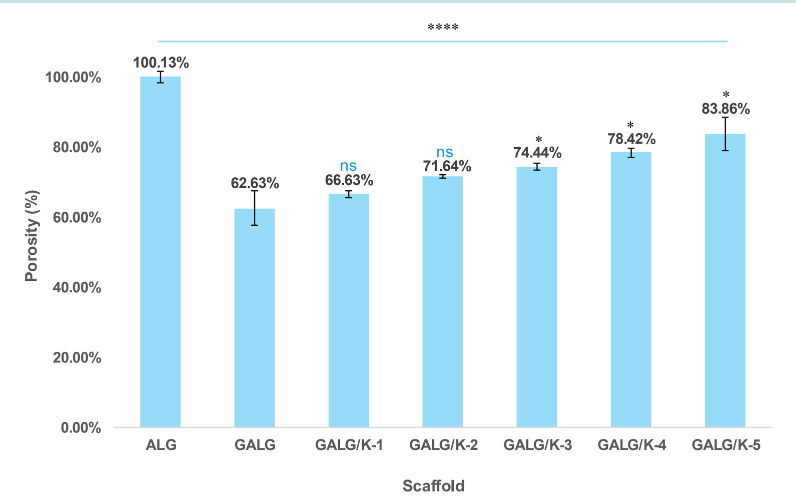

Figure 5: Comparison of Porosity of ALG, GALG, GALG/K-1, GALG/K-2, GALG/K-3, GALG/K-4 and GALG/K-5 scaffolds. (**** indicates p<0.001; * indicates p<0.05; ns indicates non-significance of result)

5. Swelling

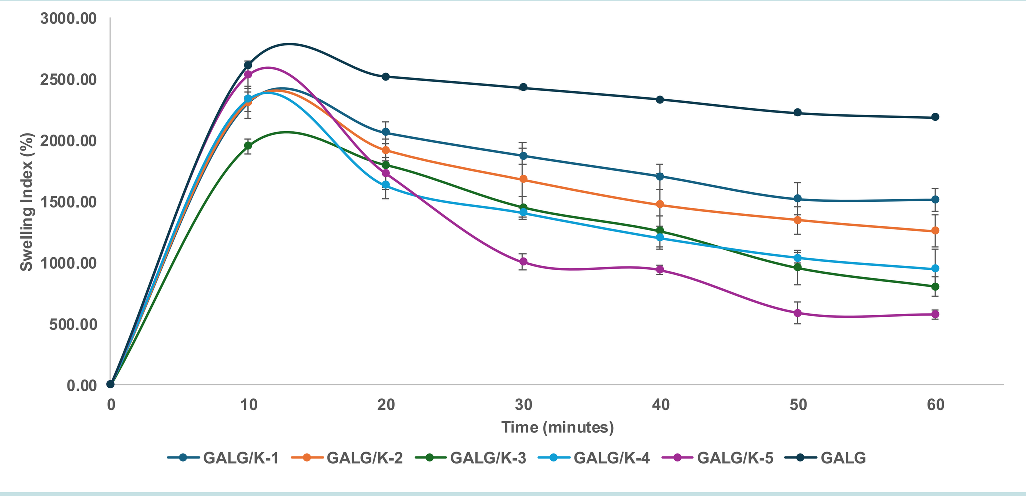

Figure 6: Comparison of Swelling Index of GALG, GALG/K-1, GALG/K-2, GALG/K-3, GALG/K-4 and GALG/K-5 scaffolds in PBS (pH 7.4) over 60 minutes.

6. Degradation

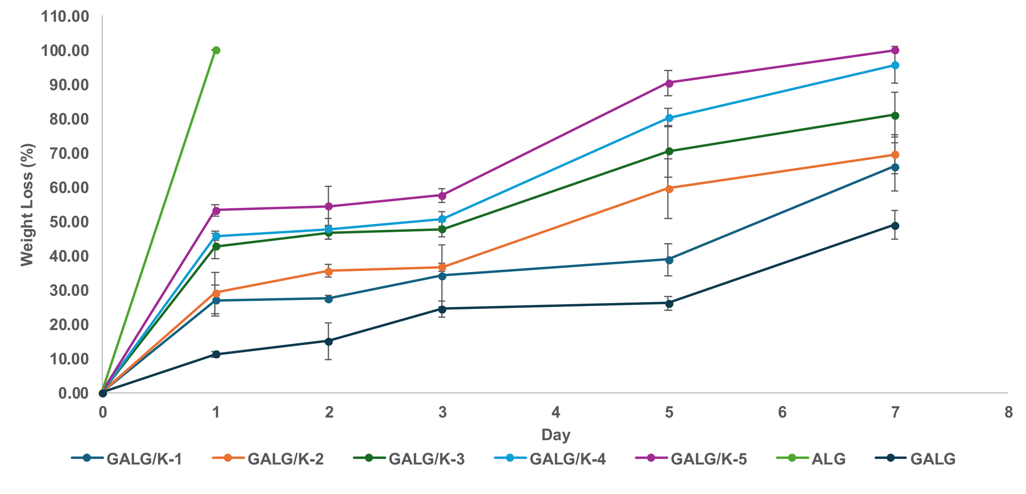

Figure 7: Comparison of Weight Loss of ALG, GALG, GALG/K-1, GALG/K-2, GALG/K-3, GALG/K-4 and GALG/K-5 scaffolds in PBS containing 0.2 mg/mL lysozyme (pH 7.4) over 7 days. (**** indicates p<0.001)

7. Gel fraction

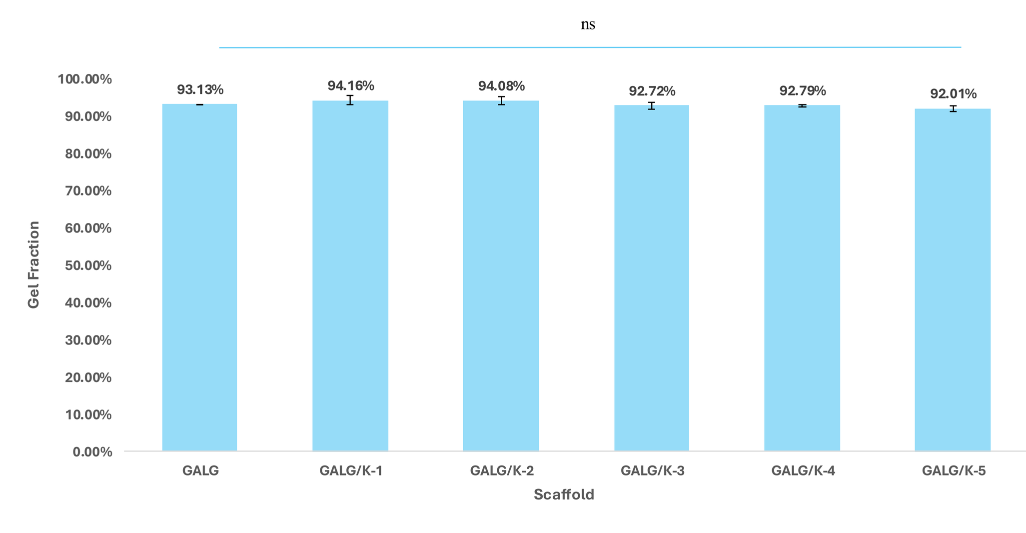

Figure 8: Comparison of Gel Fraction of GALG, GALG/K-1, GALG/K-2, GALG/K-3, GALG/K-4 and GALG/K-5 scaffolds. (ns indicates non-significance of result)

8-9. Loading Content and Encapsulation Efficiency

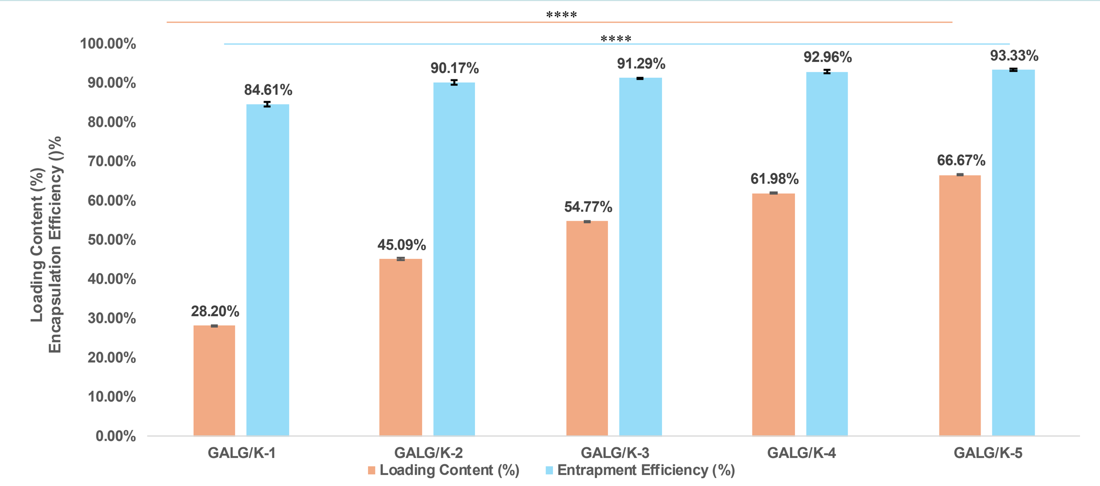

Figure 9: Comparison of Loading Content and Drug Encapsulation Efficiency of GALG/K-1, GALG/K-2, GALG/K-3, GALG/K-4 and GALG/K-5 scaffolds. (**** indicates p<0.001)

10. Antioxidant Activity

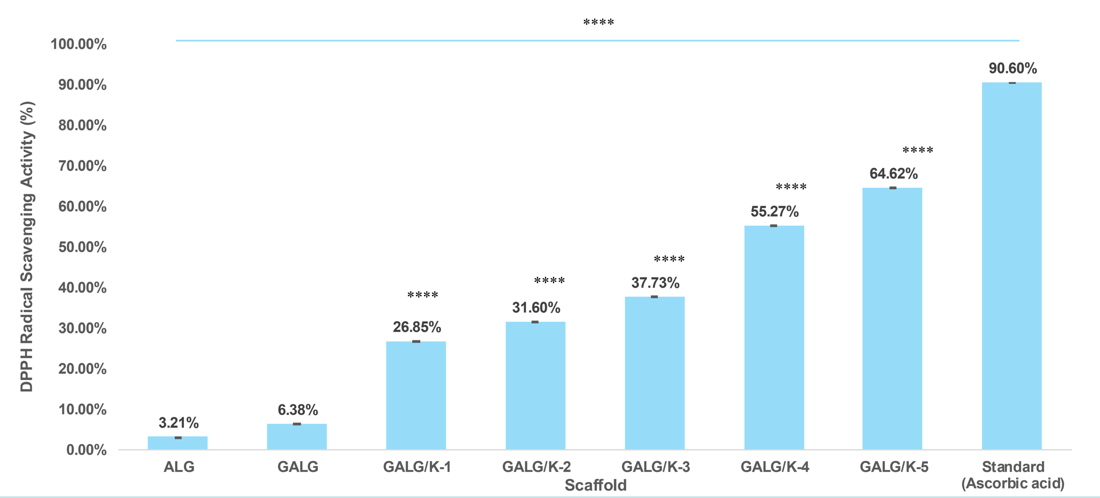

Figure 10: Comparison of DPPH Radical Scavenging Activity of ALG, GALG, GALG/K-1, GALG/K-2, GALG/K-3, GALG/K-4 and GALG/K-5. (**** indicates p<0.001)

11. Antibacterial Activity

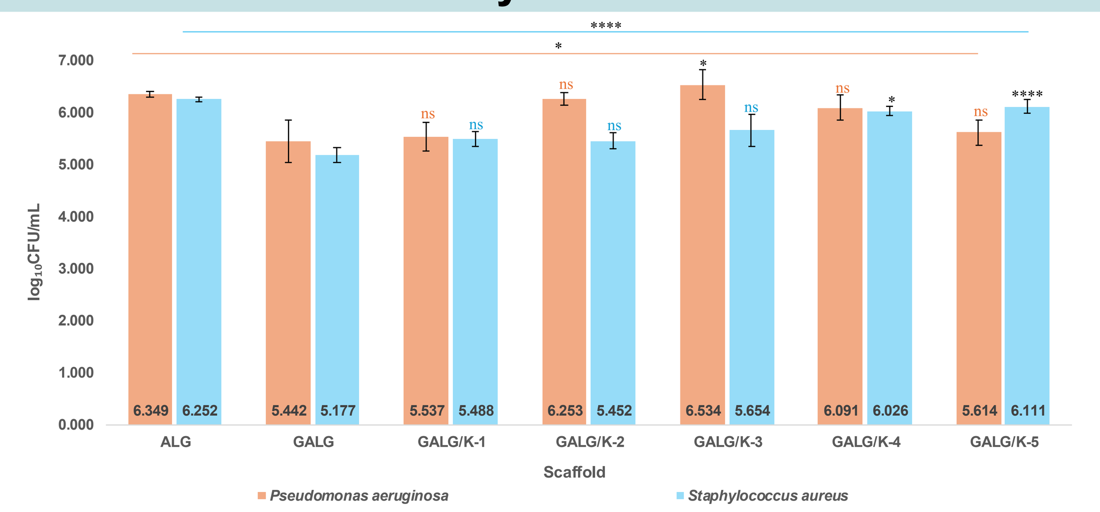

Figure 11: Comparison of Antibacterial Activity (log_{10}CFU/mL) of ALG, GALG, GALG/K-1, GALG/K-2, GALG/K-3, GALG/K-4 and GALG/K-5 scaffolds against *Pseudomonas aeruginosa* (Gram-negative) and *Staphylococcus aureus* (Gram-positive). (**** indicates p<0.001; * indicates p<0.05; ns indicates non-significance of results)

Conclusion

- GALG/K scaffolds exhibited **enhanced porosity, accelerated degradation and improved antioxidant activity**, indicating potential for **chronic wounds management applications**.
- Future studies involving **cytotoxicity assessment** and **drug release analysis** are required to evaluate the **biocompatibility** of the scaffolds.
- This study **aligns with SDG 3 (Good Health and Well-being)** by contributing to the development of advanced wound dressings that may **support chronic wound healing** by promoting chronic wound healing to reduce infection-related complications and **improve the patients' quality of life**.

References

1. Qin J, Li M, Yuan M, Shi X, Song J, He Y, et al. Gallium(III)-Mediated Dual-Cross-Linked Alginate Hydrogels with Antibacterial Properties for Promoting Infected Wound Healing. *ACS Appl Mater*. 2022 May 9;14(19):22426–42.
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3. Ojediran TK, Alagbe OJ, Victor D, Adewale E. Analysis of *Kigelia africana* (Lam.) Benth. fruit powder's antioxidant and phytochemical properties. *Braz J Sci*. 2024 May 31;3(7):38–49.