**Fabrication and Formulation of Eugenol Encapsulated Nanofibrous Scaffolds for Dual Action therapeutics in Diabetic Wound Repair**

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**Background and Aim.** Diabetic wound healing is hindered by impaired angiogenesis and slow tissue regeneration. This study aims to develop nanofibrous scaffolds using electrospinning for controlled release. The nanofibers will be characterized for morphology, drug release, and stability, with biological effectiveness assessed *in vitro* (cell proliferation, migration, angiogenesis) and *in vivo* (wound healing in diabetic models). The goal is to create a dual-action scaffold that enhances wound healing by promoting vascularization and re-epithelialization, offering a solution for chronic diabetic wounds.

**Methods.** Nanofibrous scaffolds were fabricated by electrospinning and characterized via FESEM and HRTEM for morphological and structural analysis. FTIR spectroscopy confirmed the chemical interactions between the polymer and bioactive agents. DLS and Zeta potential measurements assessed the particle size distribution and surface charge, respectively, ensuring scaffold stability. Controlled drug release was evaluated through release studies. In vitro assays demonstrated cell proliferation, migration, and angiogenesis, while in vivo diabetic wound healing models showed enhanced tissue regeneration and angiogenesis. Blood compatibility studies confirmed the biocompatibility of the scaffold.

**Results.** The biocompatible, crosslinked scaffolds, with uniform pore size and excellent hydrophilicity, showed strong antimicrobial activity against *Staphylococcus aureus* and *Pseudomonas aeruginosa*. *In vivo* testing in diabetic rats demonstrated accelerated wound contraction by day 9, with stable glycemic levels. The scaffolds reduced inflammation, promoted fibroblast activity, collagen synthesis, and fibrin regeneration. Increased CD-31, IL-1, and TGF-β levels indicated enhanced re-epithelialization, vascularization, and skin regeneration, suggesting the scaffolds could improve DFU healing outcomes.

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| **Features** | **Key Outcomes** |
| Crosslinked Scaffold | Strong structure, uniform porosity |
| Hydrophilic Surface | Supports cell adhesion & moisture balance |
| Antimicrobial Activity | Kills *S. aureus* & *P. aeruginosa* |
| In vivo (Diabetic Rats) | Faster healing by Day 9 |
| Inflammation Markers | Decreased inflammation |
| Regeneration Indicators | ↑ Fibroblasts, collagen, fibrin |
| Biomarkers (CD-31, IL-1, TGF-β) | Enhanced vascularization & re-epithelialization |
| Clinical Potential | Improved DFU (diabetic foot ulcer) outcomes |

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**Figure 1.** Topical application of nanofibrous **Table 1.** An overview on physicochemical and

scaffolds on diabetic wounds biologicalproperties of eugenol enriched scaffolds

**Conclusion/Discussion.** The eugenol-based scaffolds exhibited excellent properties, including high water uptake, porosity, mechanical strength, and biodegradability. The scaffolds showed strong antimicrobial activity and accelerated wound healing in diabetic rats. Histological analysis confirmed improved collagen formation, fibroblast regeneration, and re-epithelialization. These findings highlight the potential of using eugenol based nanofibrous therapeutics as effective diabetic wound dressings in clinical practice.

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**References**.

(1) Lv, H., Wang, S., He, M., Zhu, X., He, P., Sun, R., Jia, Z., Wang, Z., Zhao, W., Zhong, Z. and Han, Y., (2025) *Materials & Design*, *251*, p.113574.

(2) Alaa, A.L., Yehia, S., Sayed, H.A., Hussein, M.A.M., El-Sayed, E.S.M. and El-Sherbiny, I.M., (2025) *International Journal of Biological Macromolecules*, p.144832.