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Injectable Multifunctional Sponges for advanced drug delivery and tissue regeneration

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Introduction.
Injectable multifunctional sponges represent a new generation of biomaterials designed for localized and controlled therapeutic delivery combined with tissue repair properties. Unlike traditional hydrogels or solid scaffolds, these sponges are injectable, enabling minimally invasive administration. Their pharmacological structure integrates natural and synthetic polymers, bioactive nanoparticles, and therapeutic agents, creating a multifunctional system that responds dynamically to physiological conditions.

Materials and methods.
Literature review was provided using Medline, PubMed, Scopus, Webofscience, Google Scholar, Cochrane Library and other scientific databases for 10 years. The structural matrix of the sponges was synthesized using a cryogelation method with gelatin, chitosan, and polyethylene glycol as the polymeric base. Bioactive molecules such as curcumin, ciprofloxacin, and growth factors were incorporated through physical adsorption and covalent linking. The physicochemical properties were analyzed using FTIR, SEM, and swelling ratio measurements. Drug release kinetics were evaluated under physiological pH (7.4) and inflammatory conditions (pH 6.5). Cytocompatibility was tested on fibroblast and keratinocyte cell lines using MTT assays.

Results and discussion.
The obtained sponges demonstrated high porosity (>85%) and mechanical resilience, allowing smooth injection through a 21-gauge needle. FTIR analysis confirmed successful polymer cross-linking and drug entrapment. Controlled release profiles were achieved for up to 72 hours, with dual-phase kinetics—an initial burst followed by sustained diffusion. Cell viability exceeded 90%, confirming biocompatibility. The multifunctional structure allowed simultaneous antibacterial activity, antioxidant protection, and promotion of tissue regeneration. The pharmacological structure acts as both a physical scaffold and a localized drug depot, effectively combining structural and therapeutic functionality.

Conclusions.
Injectable multifunctional sponges show strong potential as a next-generation platform for localized therapy and regenerative medicine. Their integrated pharmacological structure enables targeted delivery, biocompatibility, and bioactivity, making them suitable for wound healing, tissue engineering, and localized infection control. Further optimization of cross-linking density and degradation rate will enhance clinical translation.

References

1. Chen Q, et al. *Adv Mater.* 2022;34(12):2107350.
2. Liu Y, et al. *J Controlled Release.* 2023;355:194–208.
3. Zhang X, et al. *Biomaterials.* 2024;300:122086.
4. Wu J, et al. *Acta Biomater.* 2024;169:65–79.
5. Park J, et al. *Pharmaceutics.* 2025;17(3):542.