Advancements and applications of gelatin-based scaffolds in dental engineering: a narrative review

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Abstract

Gelatin-based scaffolds have garnered significant attention in dental tissue engineering due to their biocompatibility, biodegradability, and resemblance to the extracellular matrix (ECM). This narrative review highlights recent advancements and applications of gelatin-based scaffolds for oral tissue regeneration. Various scaffold types, including hydrogels, electrospun nanofibers, hybrid composites, crosslinked matrices, and microspheres, are discussed in terms of their physicochemical characteristics, fabrication techniques, and regenerative potential. Gelatin methacryloyl (GelMA) hydrogels, for instance, exhibit favorable hydration and mechanical properties for endodontic regeneration, while electrospun nanofibers support enhanced cellular attachment and proliferation.

Hybrid scaffolds incorporating ceramics, such as hydroxyapatite or β-tricalcium phosphate (β-TCP), improve mechanical strength, making them suitable for alveolar bone regeneration. Key parameters influencing scaffold performance, including gelatin concentration, crosslinking density, pore size, and biofunctionalization, are also examined. Applications span dentin–pulp complex regeneration, periodontal therapy, and bone defect repair. Despite their promise, limitations, such as rapid degradation and mechanical weakness, necessitate optimization either through chemical modification or composite formation. The integration of emerging technologies, including bioprinting and smart biomaterials, may further enhance scaffold functionality. This review underscores gelatin's versatility and its pivotal role in shaping next-generation strategies for functional and biomimetic dental tissue restoration. © The Author(s) 2025.

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