Title: Gamma irradiation crosslinked fluorescent nanocarbon based biodegradable hydrogel for controlled release of antibiotics

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Abstract: Controlled and sustained antibiotic delivery is critical for combating antimicrobial resistance while minimizing side effects. Herein, a novel biodegradable hydrogel system, synthesized via gamma irradiation, incorporating fluorescent carbon dots (CDs) as multifunctional nano-crosslinkers, has been reported. The CDs, prepared from sustainable bio-precursors, reinforced the polymer network and enhanced the mechanical stability and swelling behavior, while simultaneously serving as intrinsic fluorescent probes for potential real-time monitoring of degradation and drug release. Thorough characterization revealed consistent morphology, adjustable biodegradability, and enhanced rheological characteristics. Drug release investigations demonstrated a diffusion-controlled mechanism, wherein the integration of CD diminished the cumulative antibiotic release from approximately 70% to approximately 40%, thereby facilitating precise regulation of release kinetics. The single-step gamma irradiation method facilitates concurrent crosslinking and sterilization, providing an efficient and scalable production strategy. This study presents a multifunctional hydrogel platform that integrates sustainable nanomaterials, regulated drug administration, and real-time monitoring, thereby facilitating the development of advanced theragnostic systems.

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