Lipid nanoparticles for treatment of bacterial biofilm infections

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Abstract:Lipid nanoparticles (LNPs) are a promising tool for treating bacterial biofilm infections, offering enhanced drug delivery, improved biofilm penetration, and increased therapeutic efficacy. These nanoparticles provide several benefits, including biocompatibility, stability, and the ability to encapsulate a broad spectrum of antimicrobial agents. Their targeted delivery system enables precise drug release at infection sites, addressing the resistance mechanisms associated with bacterial biofilms. Ongoing research and optimization of LNP formulations are expected to further improve treatment strategies for chronic and persistent bacterial infections, presenting a novel and effective approach for managing biofilm-related diseases. Preliminary screening of excipients, solvent, lipid, and surfactant was performed to optimize the formulation of lipid-core nanoparticles (LCNPs) for drug delivery through parameters such as particle size, polydispersity index (PDI), and entrapment efficiency, which are essential indicators of the stability, uniformity, and drug loading capacity of the nanoparticles. Characterization of the LCNP formulation was conducted using scanning electron microscopy (SEM), which revealed that the nanoparticles exhibited a stable and consistent structure. The in-vitro release studies further highlighted that the LCNP formulation displayed a superior release profile compared to the individual drug, ciprofloxacin HCL. This suggests that the LCNPs not only protect the encapsulated drug but also provide a more efficient and sustained release, enhancing therapeutic effectiveness. In conclusion, the LCNP formulation demonstrates superior drug delivery characteristics compared to the individual drug, ciprofloxacin. The enhanced drug release, improved MIC, and stability of the LCNPs make them a promising candidate for more efficient and targeted treatment of bacterial infections, potentially offering better outcomes in comparison to conventional drug delivery methods.

Keywords: Lipid nanoparticles, drug delivery, biofilm penetration, polydispersity index