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Multifunctional electrospun nanofibers for wound application – novel insights into the control of drug release and antimicrobial activity

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Abstract:
Therapeutic management of skin wounds is still faced with major challenges associated with chronicity and bacterial infection. Consequently, there is a high clinical need for effective therapeutic approaches addressing these aspects. In this context, electrospun fibers emerged as beneficial carrier systems for local and controlled delivery of wound healing agents, additionally providing a protective barrier against bacterial invasion. However, depending on the material, such fibers were also shown to provide a potential substrate for bacterial colonization and growth. Thus, profound understanding of fiber characteristics and the respective interactions of fibers with biological systems, cells as well as bacteria, is of major importance.
To address these issues, we designed drug-loaded hybrid fibers consisting of polycaprolactone (PCL) and chitosan. Pure PCL fibers provided suitable drug release kinetics for wound healing, but were colonized by *Pseudomonas* bacteria which were used as model pathogens. The addition of chitosan to the fiber matrix reduced the number of adherent bacteria by tenfold compared to pure PCL fibers and did not show any adverse effects to human skin cells. Further, chitosan incorporation significantly improved fiber hydrophilicity, identified as one of the key regulators of optimized cell-fiber interactions. We successfully encapsulated dexpanthenol as an established wound healing active into these hybrid fibers and solvent polarity was found to be a key factor for controlling drug release kinetics from the fibers. For the final formulation, controlled drug release over seven days with a burst release of 11.54% within 3 h could be achieved and the wound healing effect of the fiber mats could successfully be demonstrated in a cell-based wound healing assay as a proof-of-concept. Such multifunctional fibers simultaneously deliver actives and prevent bacterial growth, and consequently show a high potential for future wound therapy.

Keywords: electrospun fibers; dexpanthenol; interaction with bacteria; controlled release; wound healing