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Poly(vinyl alcohol)/polycaprolactone co-axial wet-spun fibrous scaffolds loaded with ceftazidime and vancomycin for the eradication of *P. aeruginosa* and *S. aureus* bacteria in diabetic foot wounds

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Introduction

Annually, the incidence of diabetic foot ulcers (DFUs) varies between 9.1 to 26.1 million worldwide, with numbers increasing each year. About 25% of diabetic patients develop DFUs, with near 70% of those requiring lower limb amputation. DFUs often fail to progress past the inflammatory phase due to increased bacterial colonization and recurrent infection. Over the last decades, technology breakthroughs have demonstrated the impact of bioactive 3D, fiber-based scaffolding systems in the treatment of DFUs (DOI: 10.1016/j.ijpharm.2021.120423).

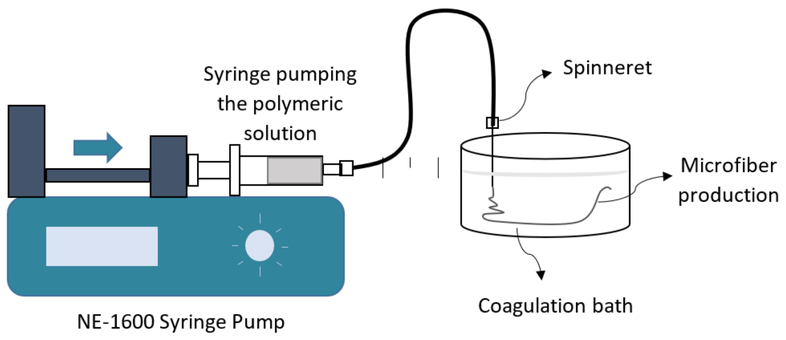
Goal of this Research

In the present project, co-axial wet-spun microfibrous scaffolds are proposed as drug delivery platforms for infection control in DFUs-prevalent bacteria infested environments.

Materials and Methods

Wet-Spinning

Non-solvent induced phase inversion approach that allows the production of continuous polymeric microfibers.



Polymeric solution preparation

Shell: poly(vinyl alcohol) (PVA) at 10wt.% in water

Core: polycaprolactone (PCL) at 10wt.% in dimethylformamide

Processing conditions

Needle diameters – Core: 21 Gauge; Shell: 15 Gauge

Flow Rate – 0.5 mL/h for core and 1.0 mL/h for shell

Coagulation bath – 8wt.% Na_2SO_4 and 4wt.% NaOH

Minimum Inhibitory (MIC) and Bactericidal (MBC) Concentrations

Starting Testing Concentration: 1.024 mg/mL, following EUCAST

Antibiotics	*Staphylococcus aureus*		*Pseudomonas aeruginosa*	
	MIC (µg/mL)	MBC (µg/mL)	MIC (µg/mL)	MBC (µg/mL)
Vancomycin	2	4	> 1024	> 1024
Ceftazidime	256	512	16	32

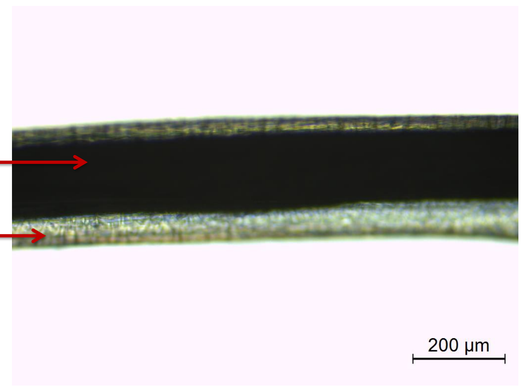
Results and Discussion

Fiber Morphology

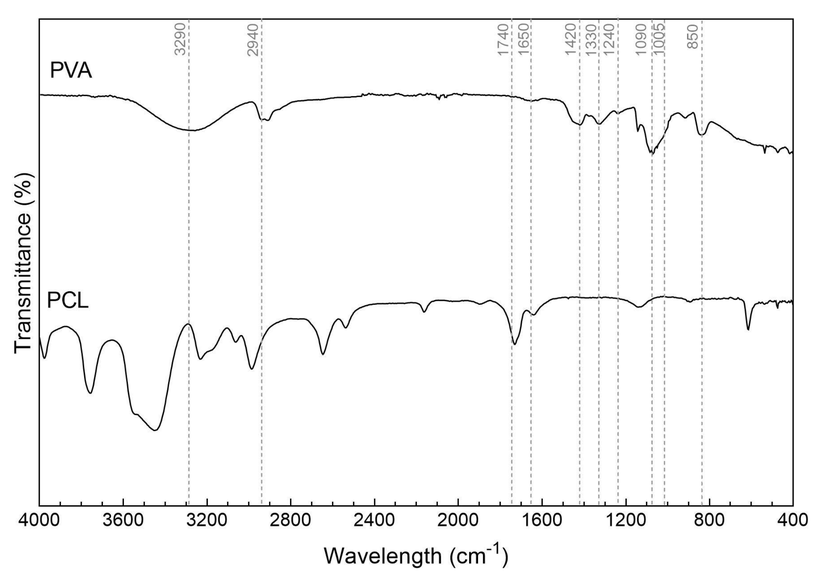
Co-axial structure

Core: PCL, provides mechanical resilience to the fiber

Shell: PVA, is biocompatible, highly absorbent and is loaded with the antibiotics, turning the scaffold antimicrobial



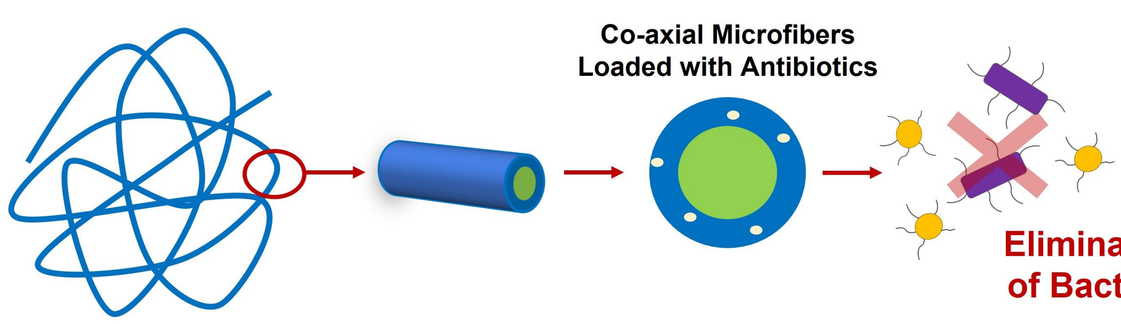
Chemical Composition of the Fibers



Swelling Capacity

Artificial exudates were used to attest the scaffold swelling capacity and map its degradation profile. Scaffolds could maintain >80% of their mass up to 28 days of incubation in dynamic conditions.

Antimicrobial Action



Conclusions: The results demonstrated the potential of PVA-PCL co-axial microfibers loaded with selected antibiotics to be constructed via wet-spinning. In the near future, their efficiency for treating infections cause by *S. aureus* and *P. aeruginosa* will be demonstrated for potential applications in diabetic foot wounds' care.

Acknowledgments

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COMPETE

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