Enhancing probiotic viability by encapsulation in electrospun alginate/α-lactalbumin fibers for otitis media cell regeneration

Samir Zergat[1,2,3] , Roberta Rovelli[4] , Beatrice Amato[1] , Semih Esin[1] , Giovanna Batoni[1] and Serena Danti[2,3]

[1]Department of Translational Research and New Technologies in Medicine and Surgery, University of Pisa, Pisa, Italy; [2]Department of Civil and Industrial Engineering, University of Pisa, Pisa, Italy; [3]National Interuniversity Consortium of Materials Science and Technology (INSTM), Florence, Italy ;[4]PEGASO Doctoral School in Life Sciences, University of Siena, Siena, Italy.

Introduction

Chronic otitis media (COM) causes middle ear tissue damage, requiring effective repair strategies [1]. Probiotics can support healing by modulating inflammation and microbiota, but viability limits their use. Encapsulating probiotics via electrospinning was investigated to improve survival and maintain bioactivity.

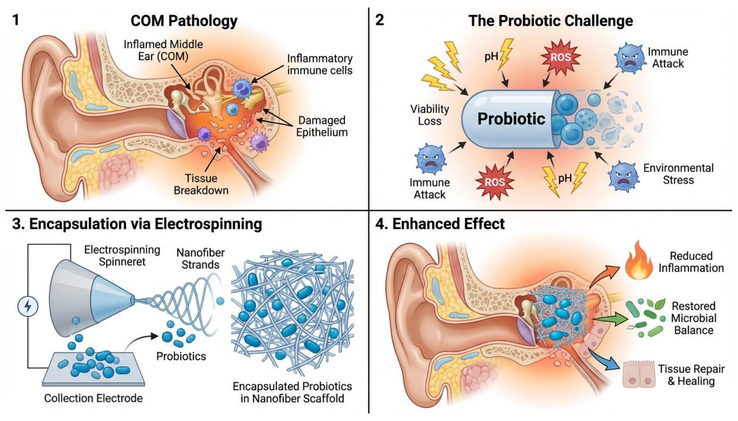


Figure 1: probiotic loaded electrospun fibers as strategy to combat middle ear cell damage

Objectives

- To Evaluate the effect of Lactalbumin and glucose on probiotic growth.
- To Develop electrospun fibers incorporating probiotics with Lactalbumin and glucose to enhance viability for tissue regeneration in COM.
- To Characterize fiber properties and assess post-encapsulation probiotic viability.

Materials and methods

- Sodium alginate (low viscosity)
- polyethylene oxide (PEO, Mw 1000 kDa)
- Triton X-100 (1%)
- calcium chloride (2%)
- DAPI
- Resazurin
- a commercial probiotic preparation 10^9 CFU/mL)
- alpha-lactalbumin (LALBA, 1–3%)
- Glucose (2% w/v)

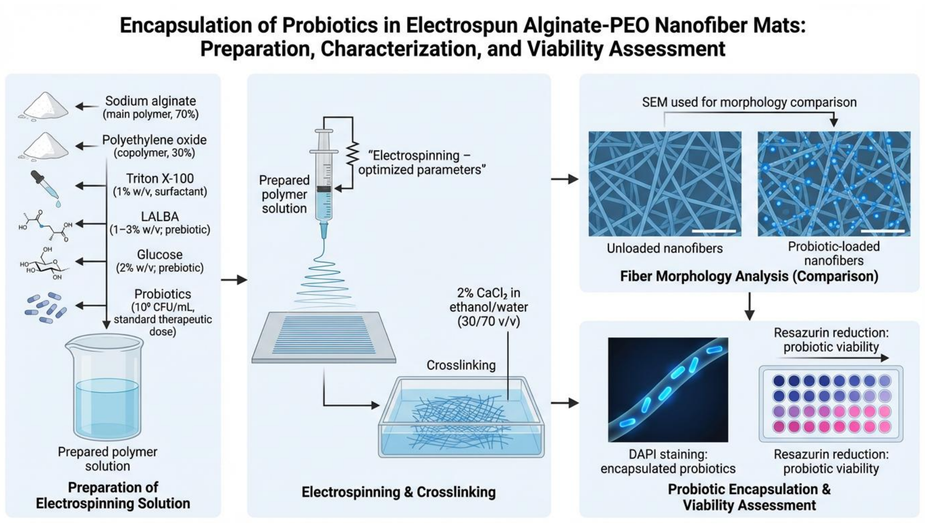


Figure 2: Methodological workflow

Results

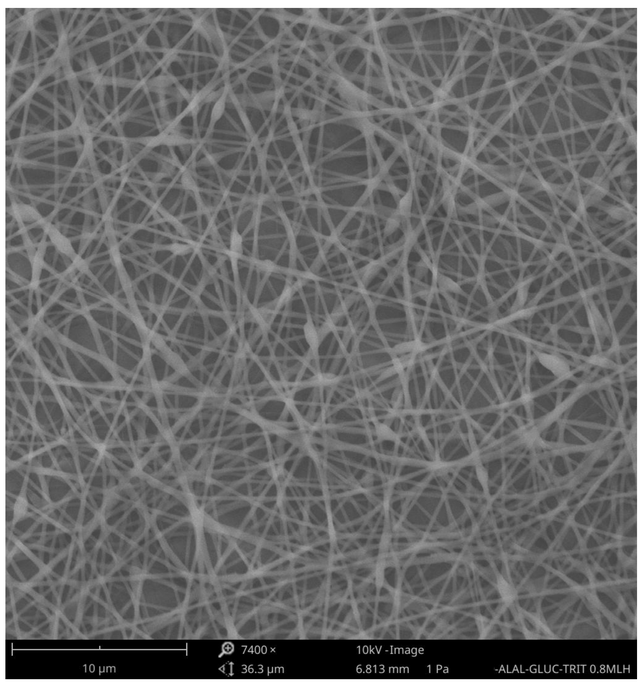


Figure 3: Scanning Electron Micrograph of electrospun probiotic loaded fibers

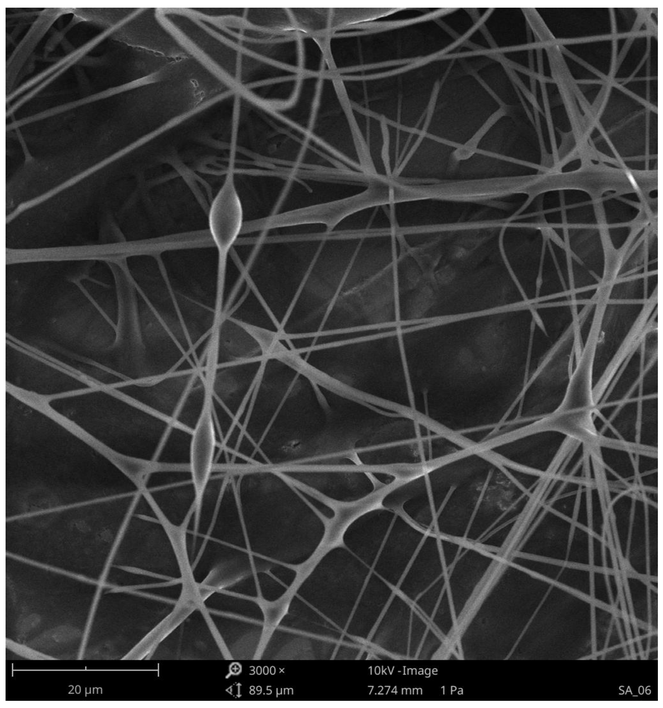


Figure 4: Scanning Electron Micrograph of electrospun probiotic loaded fibers showing continuity of encapsulation over one fiber

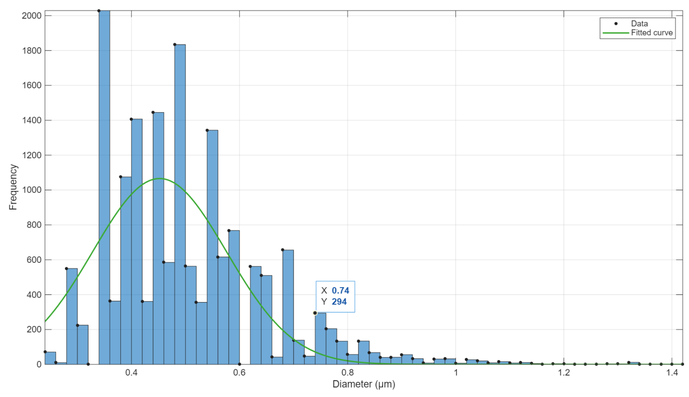


Figure 5:Fiabers diameters distribution

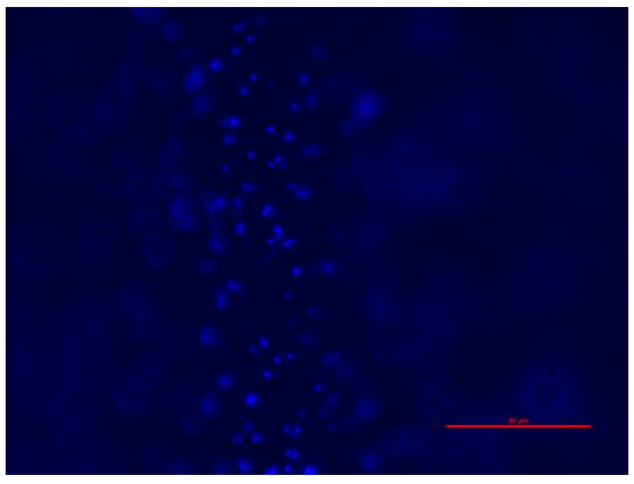


Figure 6:DAPI Staining of probiotic loaded fibers

Results

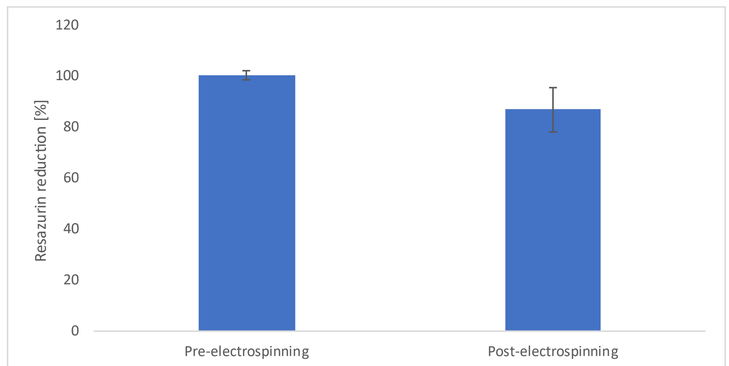


Figure 7:Resazurin dye essay result of probiotic loaded fibers showing maintained metabolic activity post electrospinning

Discussion

- SEM revealed uniform, bead-free ultrafine fibers with smooth morphology and consistent diameters, indicating optimized electrospinning conditions.
- Probiotic cells were homogeneously distributed within the fibers without aggregation, confirmed by DAPI staining. Fluorescence analysis indicated that bacterial structure was preserved during fabrication.
- Resazurin assay confirmed retained metabolic activity, demonstrating post-encapsulation viability.

Conclusion

Electrospun fibers successfully encapsulated probiotics with uniform distribution, preserving structural integrity and metabolic activity, demonstrating their potential as a delivery platform for therapeutic applications in Chronic Otitis Media.

References

[1] Yuan VG, et al. Front Immunol. 2025;16:1547206.

Acknowledgements

This work was supported by PRIN 2022: Site-directed bacteriotherapy to prevent or treat infections in the era of multidrug-resistance (BENEFIT) Prot. 2022M7PFZS; CUP I53C24002820006.

Contact Information

Samir Zergat

University of Pisa
Pisa
Italy

Email:
samir.zergat@phd.unipi.it