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PVA-based electrospun mats modified with piperine and curcumin for prospective wound healing applications

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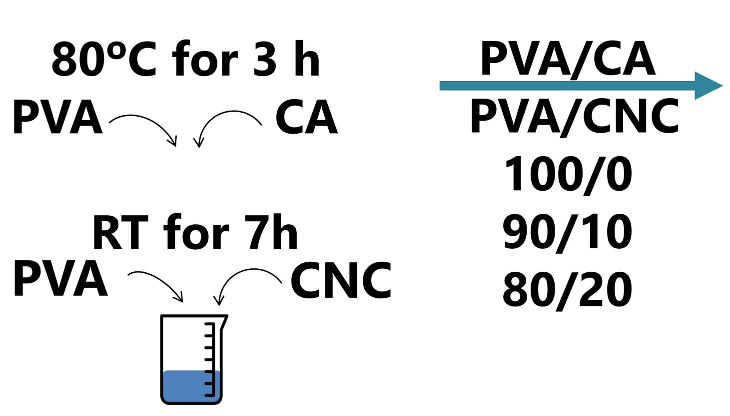
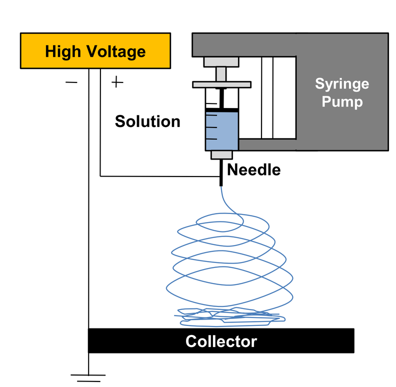
Introduction

The incidence of chronic wounds (CW) is growing at an accelerated rate around the world. To address this problem, new wound dressings functionalized with active biomolecules are being engineered to manage and treat CW [1]. The introduction of natural extracts, such as curcumin and piperine, endowed with anti-inflammatory, antioxidant and antimicrobial properties, displaying a broad spectrum of activity against pathogens and reducing bacterial resistance, has already been established as a viable solution within dressing formulations [2]. Nowadays, biocompatibility and biodegradability are assumed as essential requirements in biomedical purposes. The eletrospinning technique is an excellent candidate to produce 3D porous mats with high porosity and high surface area from a wide range of polymers with capacity to mimic the structure of the extracellular matrix [3]. The present work reports the antimicrobial effect of curcumin and piperine when immobilized onto poly(vinyl alcohol)/cellulose acetate (PVA/CA) and poly(vinyl alcohol)/cellulose nanocrystals (PVA/CNC) crosslinked mats. The modified films physical stability and morphology were also examined considering the requirements for CW healing.

Electrospun meshes production

PVA (88% hydrolyzed and Mw 78,000) was purchased from Polysciences, Warrington, USA. CA (Mw 30,000) and CNC (diameters of ≈ 75 nm and polydispersity index (PDI) of 0.181) were purchased from Sigma Aldrich, USA and CelluForce, Canada, respectively. The acetic acid (glacial) 100% was purchased from Merck, Darmstadt, Germany. Glutaraldehyde (GA, 25% aqueous solution, Sigma Aldrich).



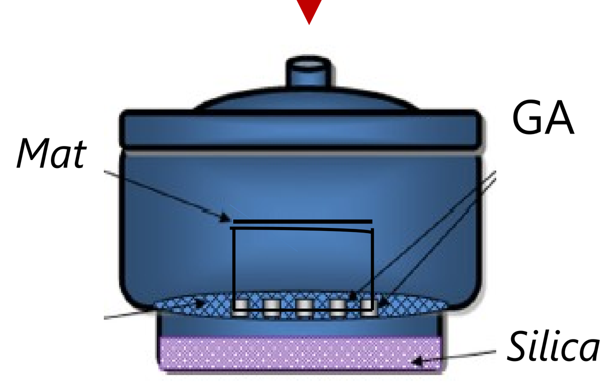


Electrospinning process

10% (w/v) of total polymeric solution for both combinations
PVA/CA: 75/25% (v/v) acetic acid/dH$_2$O (solvents)
PVA/CNC: distilled water (solvent)

Parameters applied to both combinations:
Voltage: **25 kV**;
Feed rate: **0.8 mL/h**;
Distance between syringe and collector: **18 cm**.

Temperature: **60ºC**
Glutaraldehyde exposure: **7 h**
Amount of crosslinker: **6mL**
Concentration: **2.56M**
Drying temperature: RT in a controlled desiccator



Crosslinking process

Characterization

Analyses of the nanofibers' morphology (e.g. 80/20 PVA/CA and PVA/CNC)

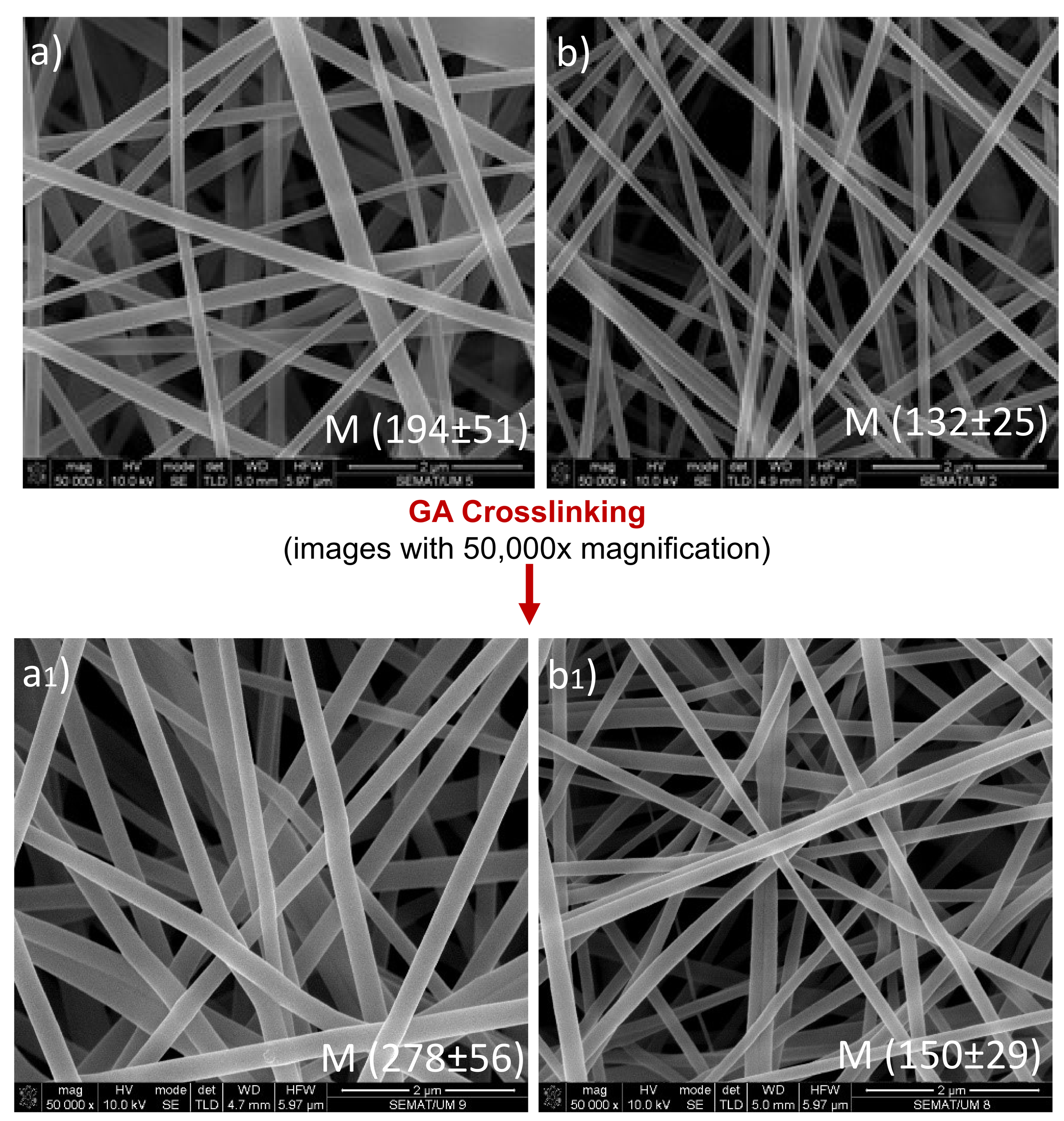
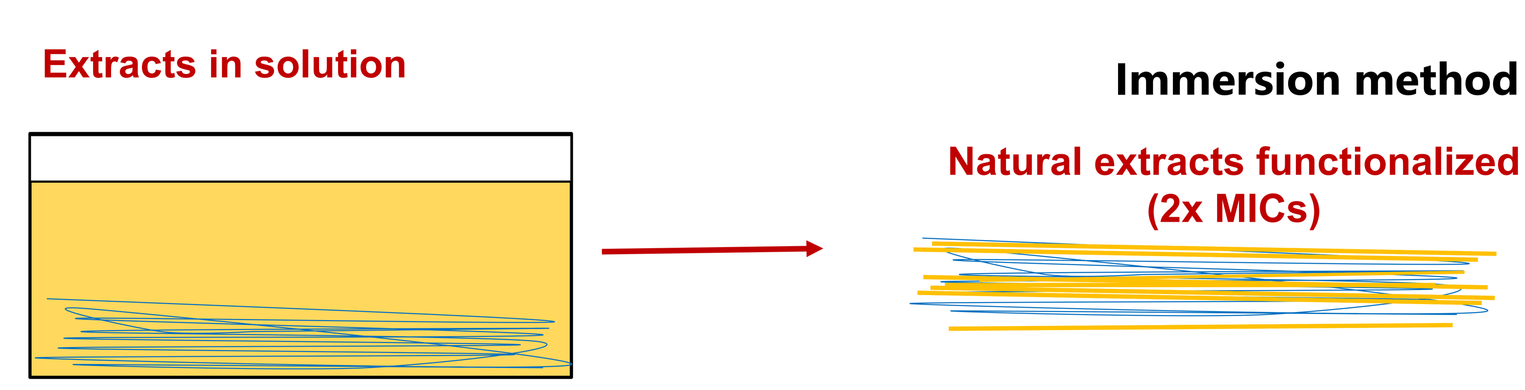


Figure 1: FEG-SEM image of 80/20 uncrosslinked (a) PVA/CA and b) PVA/CNC) and crosslinked (a1) PVA/CA and b1) PVA/CNC) nanofibers (n=50) with respective means (M) of nanofibers diameters.

Functionalization of electrospun mats with Curcumin and Piperine

Mats were functionalized through immersion method with the antimicrobial agents at 2xMIC value (7.8-31.2 μg/mL to curcumin and 31.2-125 μg/mL to piperine) and their antimicrobial action accessed against *Staphylococcus aureus* (*S. aureus*).



Conclusions

Curcumin was the most effective biomolecule. These biomolecules showed great potential as substitutes of antibiotics in the fight against *S. aureus* bacteria.

References: [1] Felgueiras, H. P., et al., Colloids Surf. B. 2017;156:133–148.; [2] Shityakov, S.,et al., Eur. J. Med. Chem. 2019;149-161.; [3] Agarwal, et al., Polymer. 2008, 49,5603-5621.

Acknowledgments
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COMPETE
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