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Natural extract-loaded wet-spun fibers and hydrogel for potential uses in the treatment of skin infections

Marta O. Teixeira[1]*, Carla Silva[2], Joana C. Antunes[1], Helena P. Felgueiras[1]

[1]Centro de Ciência e Tecnologia Têxtil (2C2T), Universidade do Minho, Portugal

[2]Centre for Biological Engineering (CEB), Universidade of Minho, Portugal

*martasofia.teixeira@hotmail.com

Introduction

Natural extracts are emerging as potential alternatives to the use of antibiotics to fight infections, by exhibiting excellent antimicrobial profiles, good anti-inflammatory, antioxidant and chemo-preventive properties. To prevent overdose these are often incorporated into different fiber or hydrogel-based scaffolds. These structures increase the potential for treating skin infections due to their similarities to the structure of the skin, specifically the matrix and fibrillar elements, respectively. Here, we envision the evaluation of the antimicrobial efficacy of the natural extract's thymol and eugenol against two bacteria commonly associated with infections: *Staphylococcus aureus (S. aureus)* and *Staphylococcus epidermidis (S. epidermidis)*. Furthermore, the extracts are incorporated into structures such as PCL fibers and PVA hydrogel, respectively.

Goal of this Research

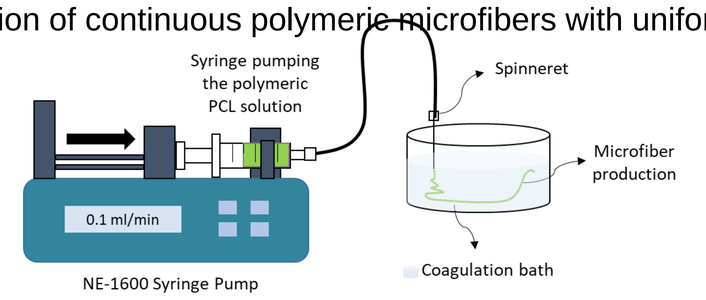
Development of a delivery platform for natural extracts incorporated in hybrid fiber-hydrogel architectures, for the control of skin infections.

Thymol incorporated into PCL fibers ✚ Eugenol incorporated into PVA hydrogel

Materials and Methods

Fiber production

Wet spinning is based on the non-solvent-induced phase version that allows the production of continuous polymeric microfibers with uniform morphology.



Polymeric solution preparation

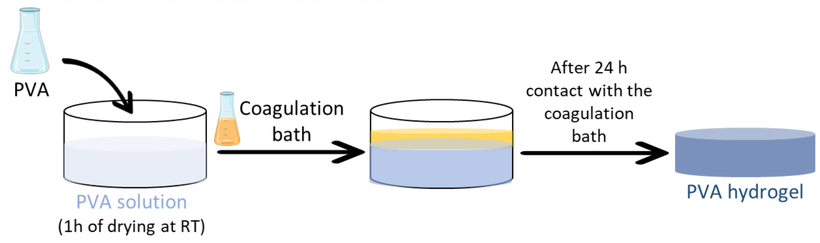
PCL at 9 wt% in dimethylformamide (DMF);
Solubilization conditions – 1h at 50 ºC and 300 rpm

Processing conditions

Flow Rate – 0.1 mL/min
Needle Gauge – 18
Coagulation bath – distilled water

Hydrogel production

Hydrogels can be obtained from synthetic and/or natural polymers through physical and/or chemical methods.



Polymeric solution preparation

PVA at 10 wt% in distilled water;
Solubilization conditions – 3h at 80 ºC and 300 rpm

Coagulation bath - 8% NaOH and 4% Na_2SO_4

Results and Discussion

Minimum Inhibitory Concentrations (MICs)

Initial Bacteria Concentration: $5x10^6$ CFUs/mL in MHB

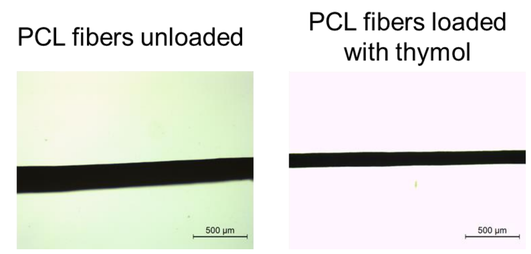
Natural extract	MICs (mg/mL)	
	S.aureus	***S. epidermidis***
Thymol	0.313	0.627
Eugenol	5.000	5.000

These preliminary data show that these natural extracts are good antibacterial agents.

Fiber Morphology

Uniform and homogeneous fibers (small defect identified)

Incorporation of thymol into PCL fibers decreases diameter and elongation to break



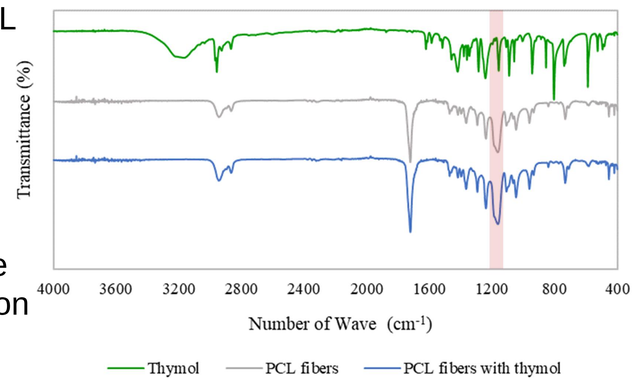
Parameters	Unloaded	Loaded with thymol
Diameter	247.49 ± 54.45 µm	146.99 ± 11.01 µm
Elongation at break	159.32 ± 84.03%	93.26 ± 23.62%

Chemical Confirmation of Thymol Incorporation

Chemical groups characteristics of PCL were detected→ Confirmation of fiber composition

Chemical groups characteristic of thymol not detected

The characteristic odor of thymol in the modified fibers confirms its incorporation into the fibers

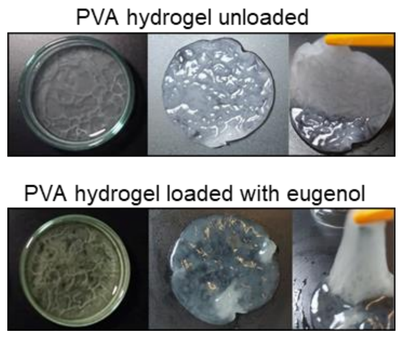


Hydrogel Morphology

Smooth hydrogels with a soft, flexible and malleable structure

The addition of eugenol:

-Did not change the thickness or integrity of the PVA hydrogel.
-Made the hydrogel more flexible



Conclusions: The results demonstrated that both thymol and eugenol are effective against the Gram-positive bacteria *S. aureus* and *S. epidermidis*. In addition, it was possible to produce fibers with thymol and hydrogels with eugenol with the desired characteristics.

Acknowledgments

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