

Evaluation of essential oil-loaded nanofibrous mats against the *Escherichia* virus MS2, a mimic of SARS-CoV-2, for prospective personal protective equipment uses

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Introduction

In December 2019, a novel strain of coronavirus, SARS-CoV-2, was identified. Infected patients revealed symptoms of fever, cough (dry), sore throat, and fatigue, which began manifesting after 5 days of incubation. Hoping to prevent transmission, many countries adopted a mandatory mask use in closed public spaces. However, most mask options display a passive action against COVID-19. To overcome such restrictions, this work proposes the incorporation of anti-viral essential oils (EOs) loaded onto a nanofibrous layer that can be adapted to both community and commercial masks.

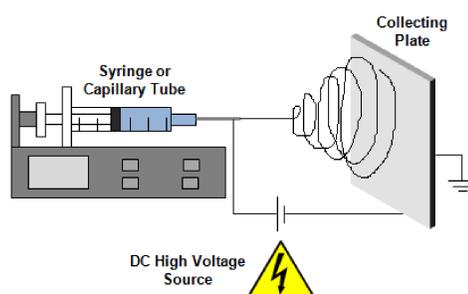
EOs Drawbacks

- cytotoxic at increased concentrations, which prevents systemic delivery;
- present low resistance to degradation by external factors (e.g., temperature, light, moisture);
- highly volatile in their free, unloaded form.

Materials and Methods

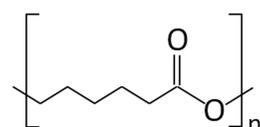
Electrospinning

Spinning technique that allows the production of continuous, homogeneous nanofibers.



Polymeric solution preparation

Polycaprolactone (PCL)



Why PCL?

- Food and Drug Administration (FDA)-approved;
- Drug loading efficiency (i.e., EOs biomolecules);
- Excellent mechanical strength, non-toxic, hydrophobic, biodegradable, etc.

PCL at 14 wt.% in chloroform/dimethyl formamide (CHF/DMF at 9/1 v/v)

Electrospinning processing conditions

Potential: 23 kV
Extruding Speed: 0.7 mL/h
Distance to Collector: 26 cm
Needle (inner diameter): 18 gauge

Essential Oils (EOs) Selection

20 EOs* with antimicrobial potential were examined for their minimum inhibitory concentrations (MICs) against the MS2 *Escherichia* host and for their virucidal concentration (VC) against the MS2 virus, mimic of SARS-CoV-2, at initial concentration of 1×10^7 CFUs or PFUs/mL, respectively.

EOs	MICs against MS2 host (mg/mL)	VC against MS2 virus (mg/mL)
Lemongrass (LGO)	178.0	356.0
Niaouli (NO)	45.7	365.2
Eucalyptus (ELO)	>	586.0
Orchid	85.6	428.0
Tea Tree Oil	22.4	447.5
Clove	105.6	528.0

*DOI: 10.3390/biom10081129

Acknowledgments

This work is financed by FEDER funds through COMPETE and by national funds through FCT via the projects POCI-01-0145-FEDER-028074 and UID/CTM/00264/2021.

Results and Discussion

Nanofiber Loading

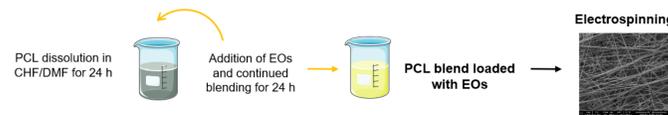
Strategy 1

Physical adsorption of the EOs at the surface of the electrospun PCL mats (label PCLaEOs)



Strategy 2

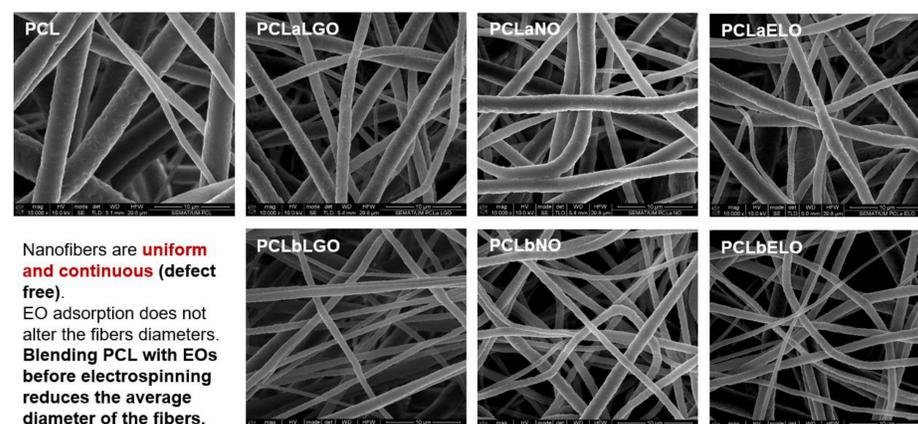
Blending the PCL solution with the selected EOs (label PCLbEOs)



Loading Amount:
10% of VC

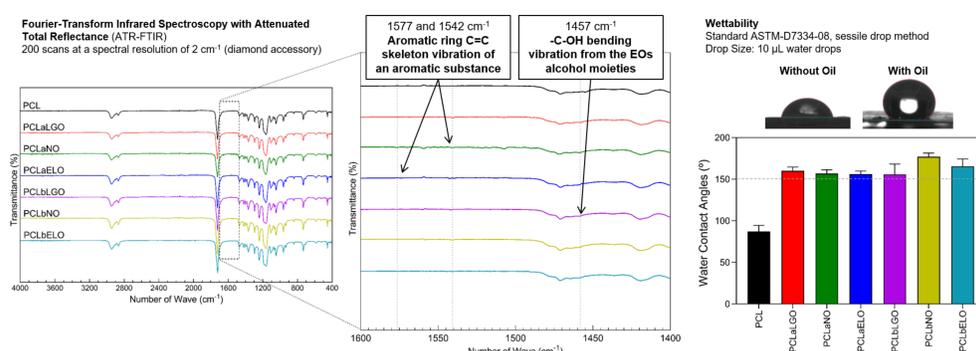
(> 10% VC turned the mats sticky and the fragrance too intense)

Nanofiber Morphology



Nanofibers are **uniform and continuous** (defect free).
EO adsorption does not alter the fibers diameters.
Blending PCL with EOs before electrospinning reduces the average diameter of the fibers.

Confirmation of EOs Loading

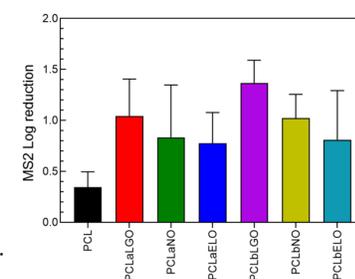


Antimicrobial Effect

Contact Killing Examinations

Microorganism: Bacteriophage MS2 (mimic of SARS-CoV-2)
Initial Concentration (t = 0 h): 3.8×10^7 PFUs/mL
Incubation Period: 4 h
Temperature: room

MS2 reduction was observed after 4 h of interaction on all EO-loaded mats. **PCL blended with LGO was the most effective from the group in fighting the virus.**
PCL on its own was also seen to retain virus within its structure, attesting to its functionality as a potential retaining layer for masks.



Conclusions: Data demonstrated the potential of these EOs-loaded PCL/CA nanofiber mats to work as COVID-19 active barriers for individual protection masks.