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Essential oils-loaded nanofibrous mats for an enhanced protection against SARS-CoV-2

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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.

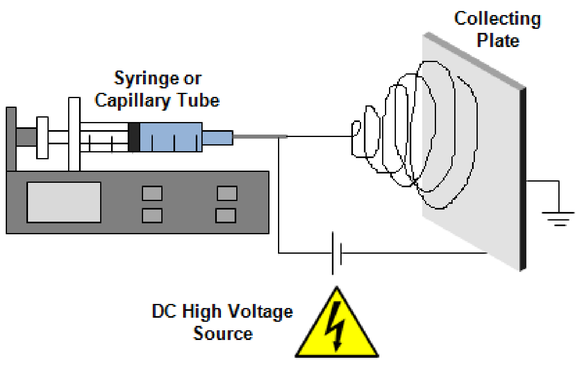
EOs Drawbacks

- 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

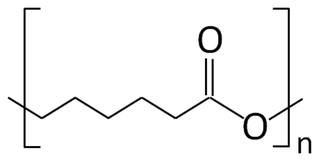
Electrospinning

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 1x107 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

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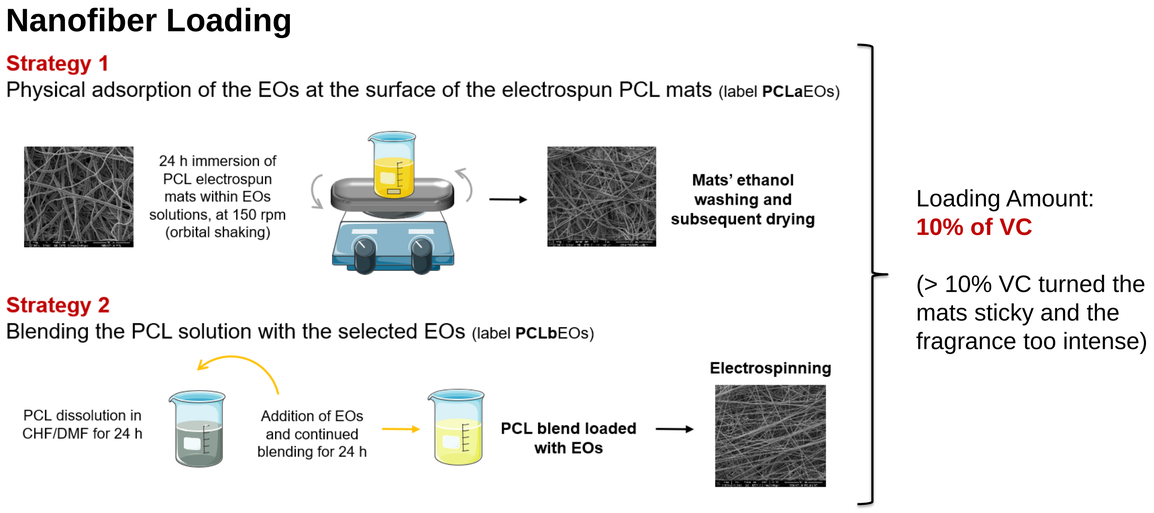
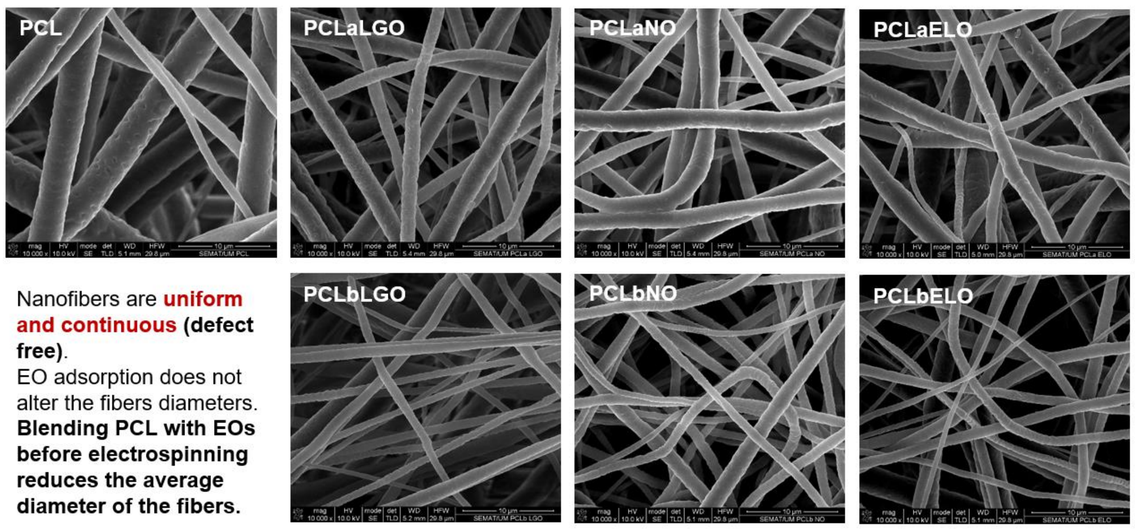
Results and Discussion

Nanofiber Loading

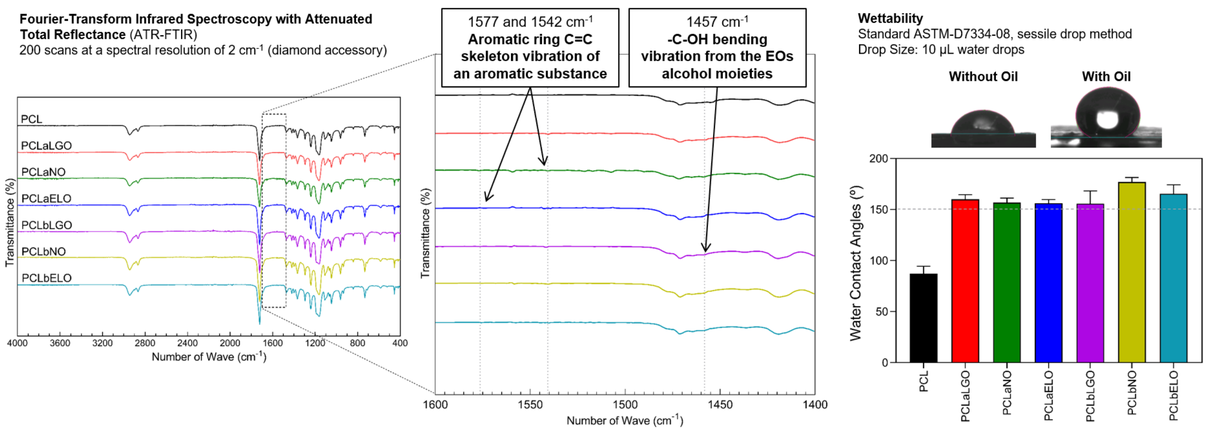


Nanofiber Morphology



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.

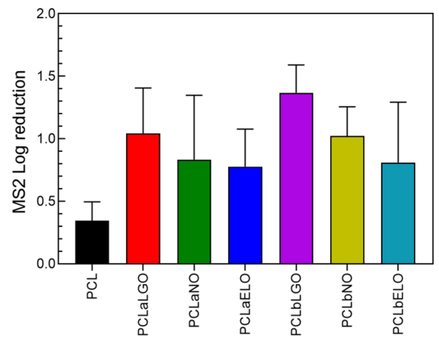
Confirmation of EOs Loading



Antimicrobial Effect

Contact Killing Examinations
Microorganism: Bacteriophage MS2 (mimic of SARS-CoV-2)
Initial Concentration (t = 0 h): $3.8x10^7$ 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.

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