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Biodegradable wet-spun fibers as delivery platforms for the bactericidal effect of the natural-origin biomolecules, cinnamon, clove and cajeput essential oils

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Introduction

Essential oils (EOs), which are complex biomolecules composed of volatile compounds, have emerged as a new strategy to deal with bacterial infections and as a valid alternative to synthetic drugs in the treatment of chronic wounds (CW) by promoting the regeneration of damaged tissues.

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.

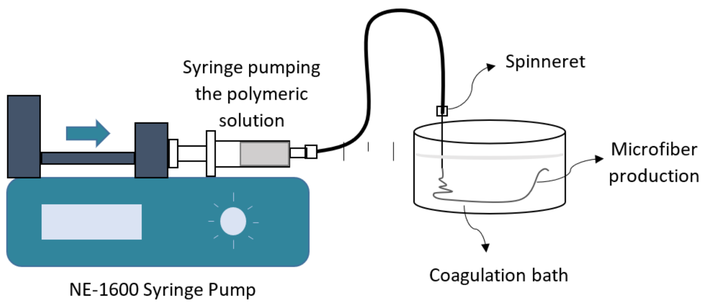
Goal of this Research

Engineer a biodegradable microfibrous target-delivery platform for EOs, that overcomes these biomolecules limitations for applications in infection control.

Materials and Methods

Wet-Spinning

Non-solvent induced phase inversion approach that allows the production of continuous polymeric microfibers.



Polymeric solution preparation

Solvents – acetic acid and acetone
Polymer ratio – 3:1 CA/PCL (10/14 wt%)
Solubilization conditions – 1 h at 75 ºC and 200 rpm

Processing conditions

Flow Rate – 0.5 mL/h
Needle Gauge – 18
Coagulation bath – Ethanol

EOs Minimum Inhibitory Concentrations (MICs)

EOs	*Staphylococcus aureus* MIC (mg/mL)	*Escherichia coli* MIC (mg/mL)
Cinnamon Leaf (CLO)	0.82	0.82
Clove (CO)	0.83	0.83
Cajeput (CJO)	22.38	11.19

Fiber Loading: incubation at room temperature at 200 rpm in ethanol-based solution containing the CLO, CO and CJO at 2xMIC for 72 h (time determine for maximum loading efficiency).

Results and Discussion

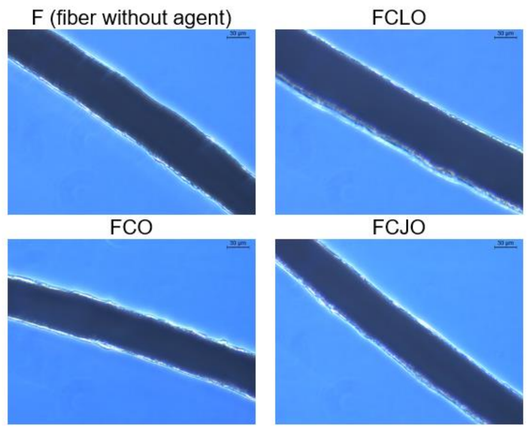
Loading Efficiency

EOs	Loading (MIC %, SD < ± 3.0%)	Concentration (mg/mL)
Cinnamon Leaf (CLO)	14.42	0.12
Clove (CO)	66.08	0.55
Cajeput (CJO)	76.48	17.12

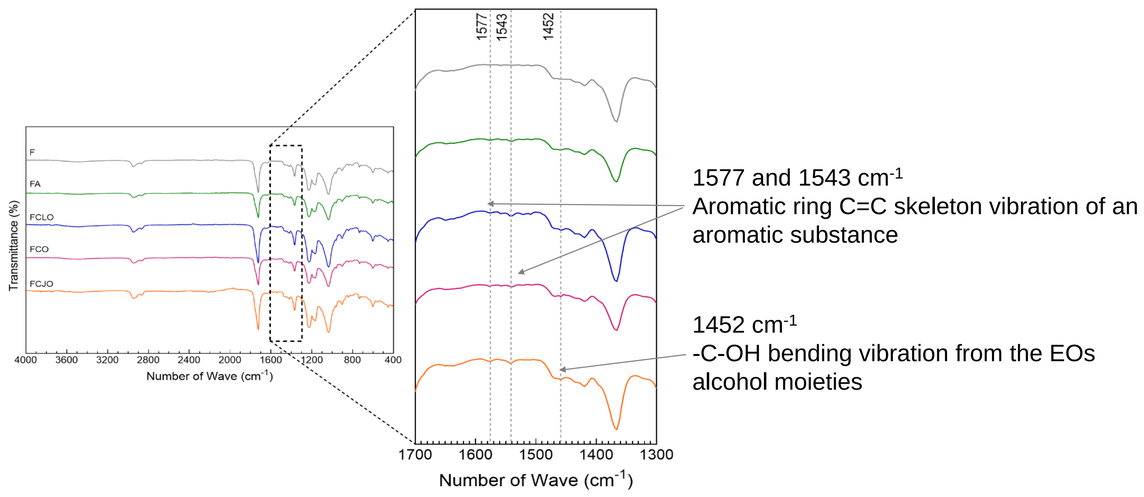
Fiber Morphology

No alterations introduced by EOs loading.

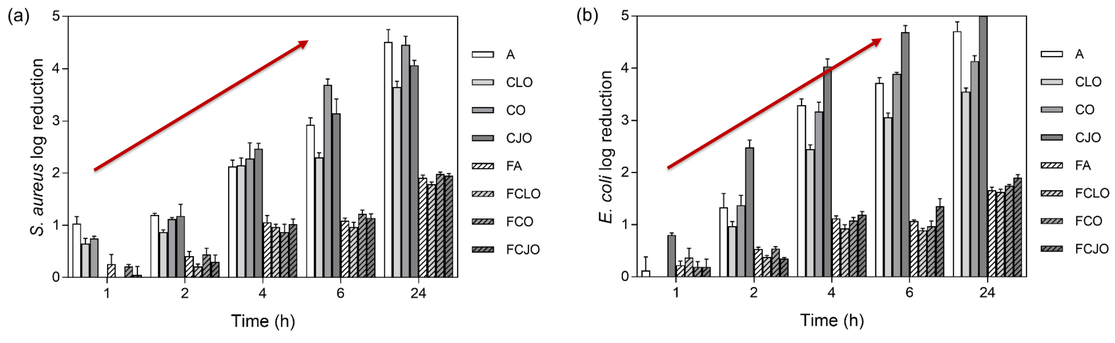
Uniform, homogeneous fibers (defect free) with an average diameter of 54-59 µm.



Chemical Confirmation of EOs Incorporation



Antimicrobial Action



(Control: A – ampicillin, FA – fiber loaded with ampicillin)

Log reduction was most significant after 24 h of culture. At this point, it was evident that *S. aureus* was more susceptible to the prolonged action of the EOs than the *E. coli*, the only exception being the CJO.

Conclusions: The results demonstrated the potential of CA/PCL wet-spun microfibers loaded with EOs for applications in biomedicine, in which treatment of infections are a main target.
For more details please refer to **DOI: 10.3390/biom10081129**

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