Biopolymer-Stabilized Emulsions for the Encapsulation of *Trichoderma* Conidia Towards Biological Control

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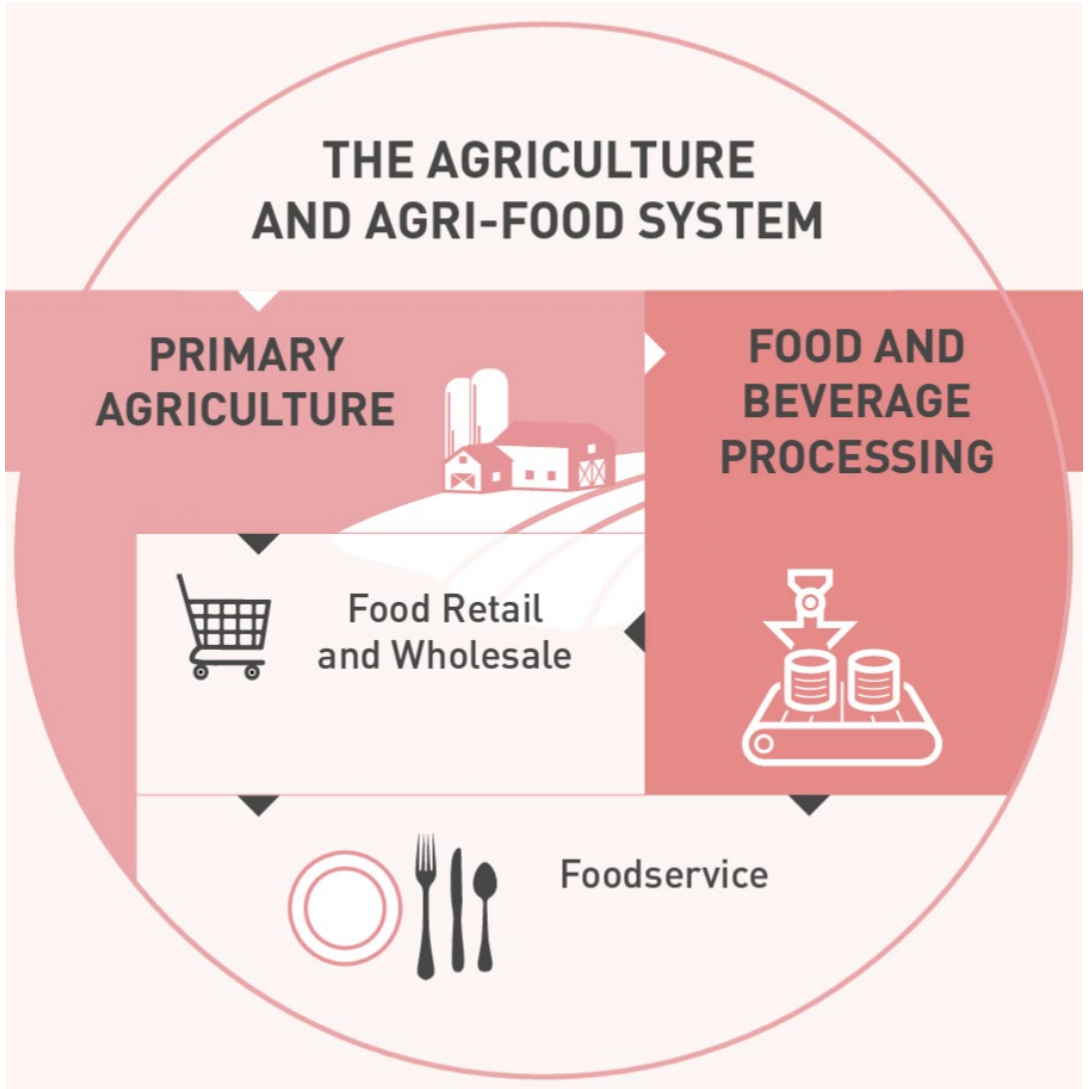
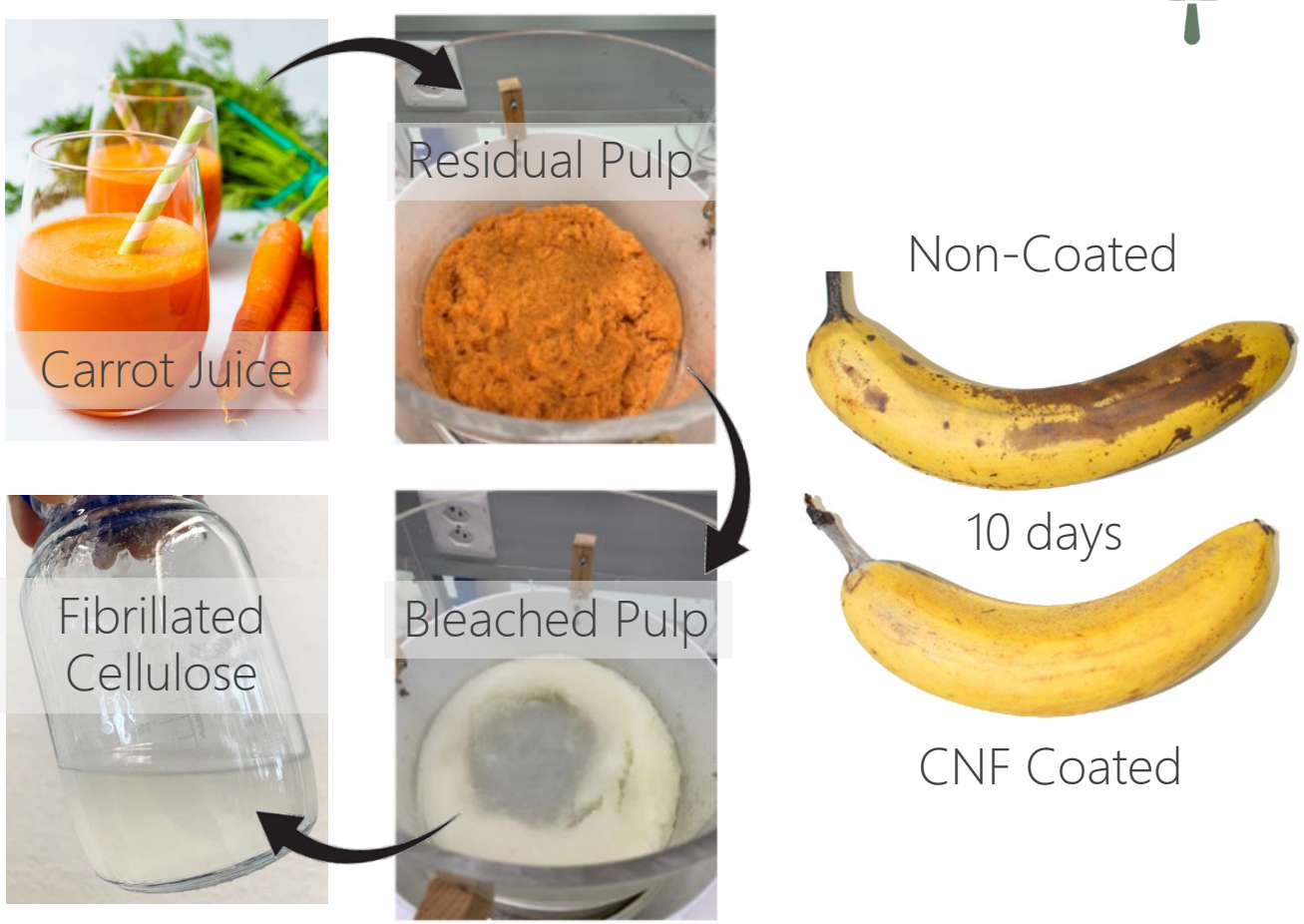
Agri-Food Management



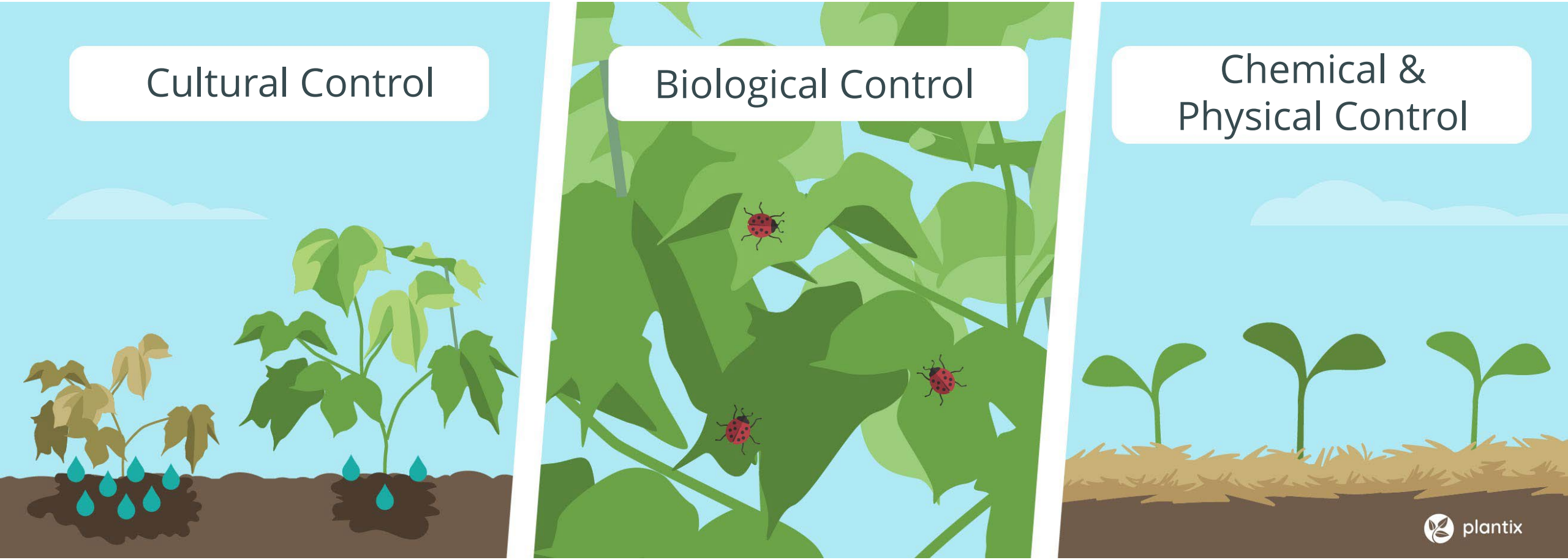


K. J. De France †, L. Amoroso † et al., *ACS Sus. Chem. & Eng.* **2022**, *10*, 342-352
L. Amoroso, K. J. De France et al., *Int. Journal of Biological Macromolecules* **2023**, *242*, 124869

Primary Agriculture in Canada

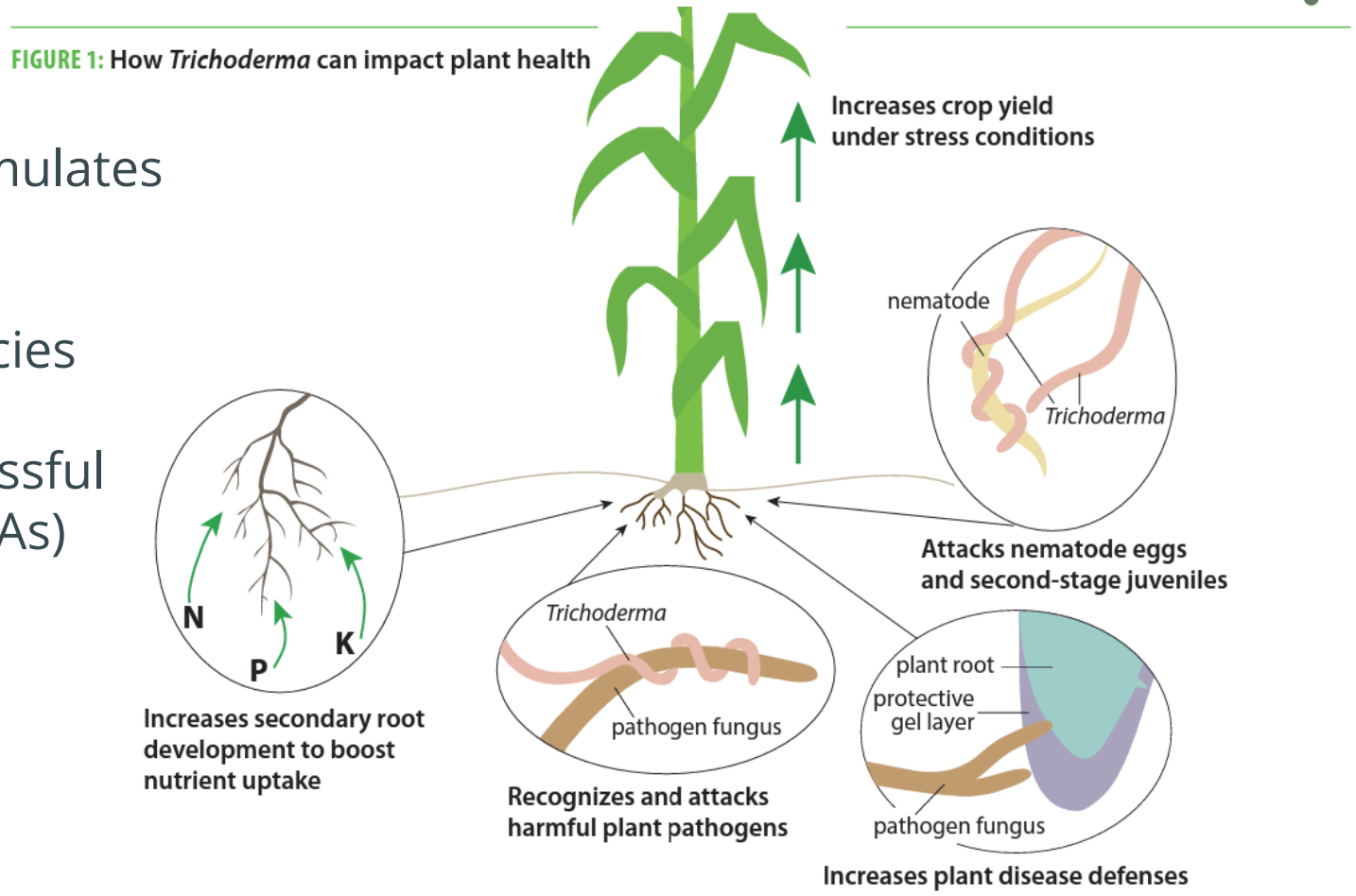
In 2021…
~ 250,000 people employed
~ $3.2 billion (1.6 % of GDP)

Control in Agriculture



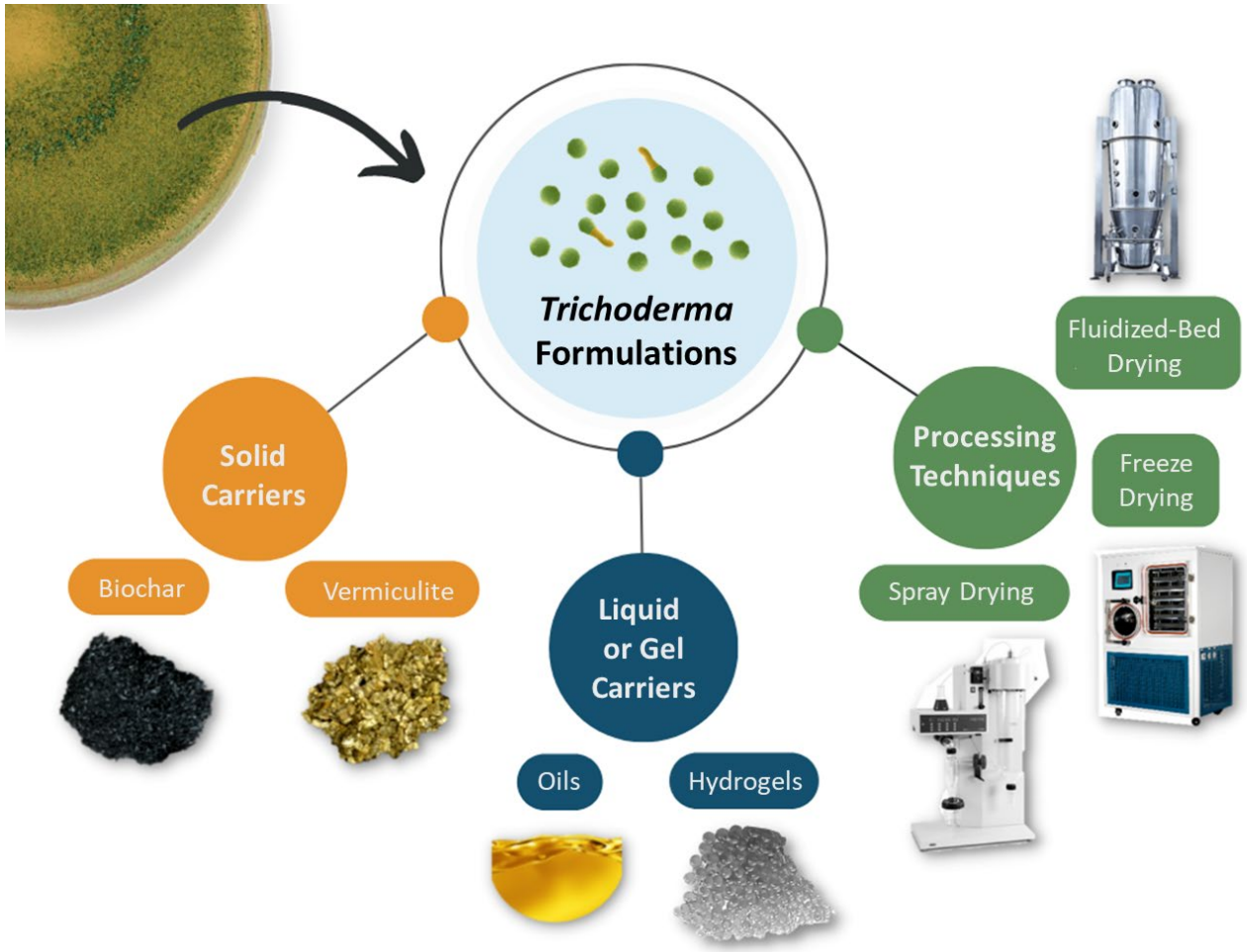
Trichoderma spp.

- Soil-borne symbiotic fungi which stimulates plant growth & defense responses
- Out-competes plant-pathogenic species
- One of the most commercially successful class of biological control agents (BCAs)
- Commercial formulations require:
  - Viable propagules (conidia)
  - Effective delivery system

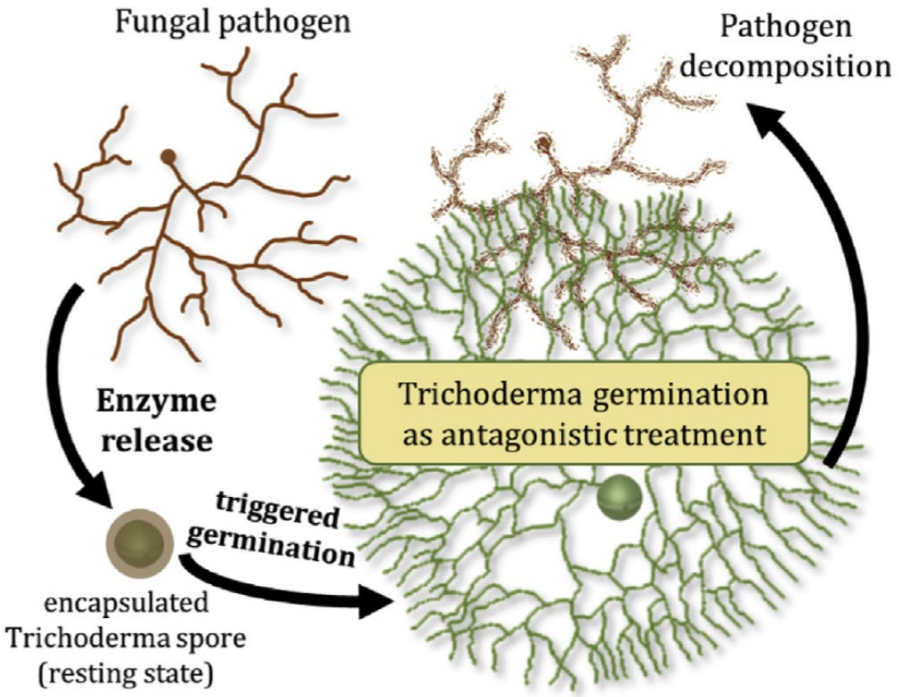


G. Siemering et al. **2016** *The Value of Trichoderma for Crop Production*. University of Wisconsin–Extension.

Formulation Development



- Encapsulate conidia in a carrier substance & process to retain dormancy
- Upon application, conidia germinate to effect control



S. Peil et al. *Materials Today Bio* **2020** *7*, 100061
Y. Martinez, K.J. De France et al. *In Revision* **2023**

Biopolymer-stabilized emulsions for encapsulating *Trichoderma* conidia

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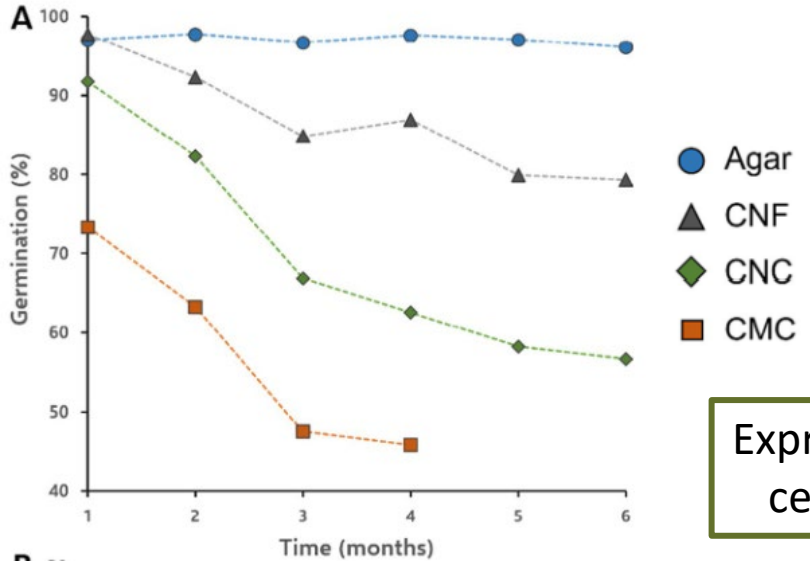
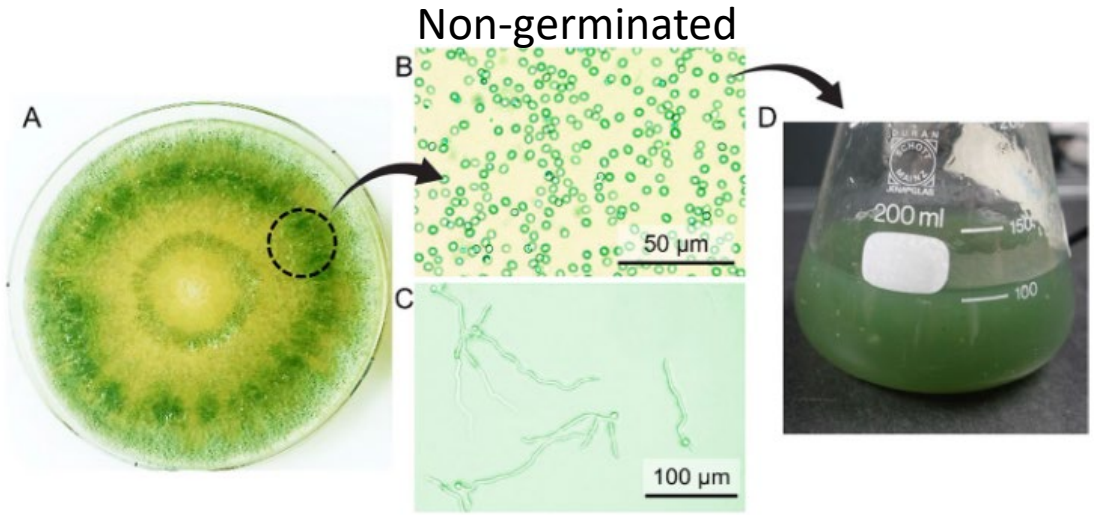
Biopolymer Selection: Viability

- Aqueous biopolymer suspensions mixed with *Trichoderma* conidia & stored for up to 6 months
- Growth media added to promote germination → viability



Expression of cellulases



Biopolymer	Germinated spores	Non-germinated spores	Viability (%)
Agar	220	4	98.2
CMC	240	18	93.0
CNF	228	6	97.4
CNC	225	13	94.5
Pectin	–	–	–
Xanthan	–	–	–

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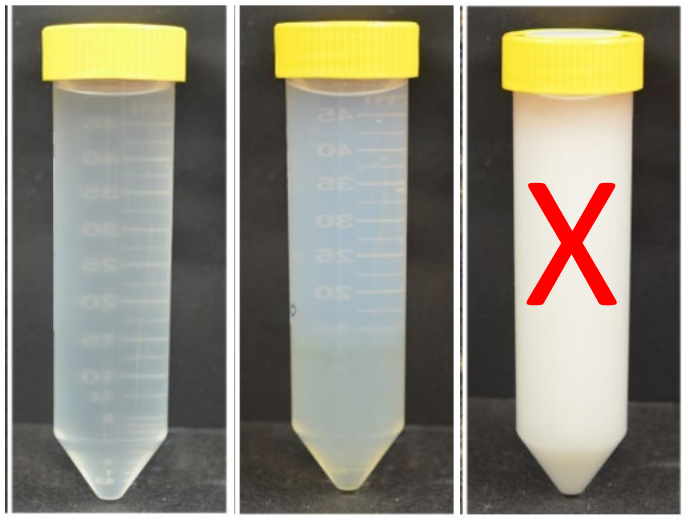
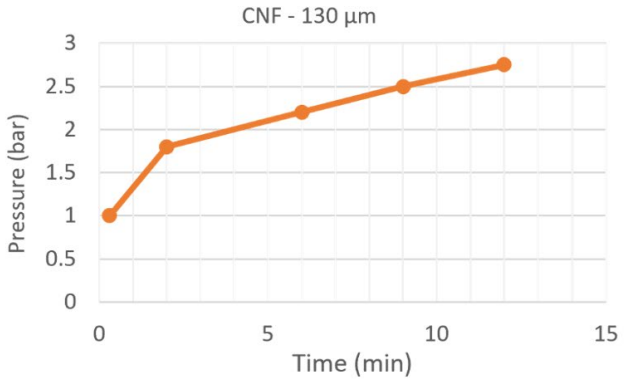
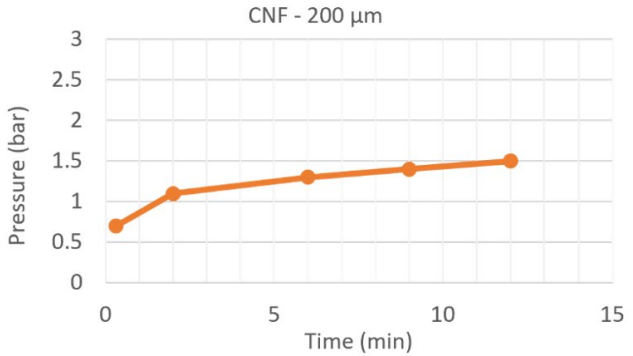
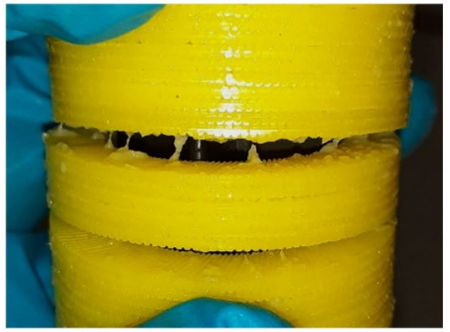
Biopolymer Selection: Delivery

- Agricultural irrigation systems & foliar application









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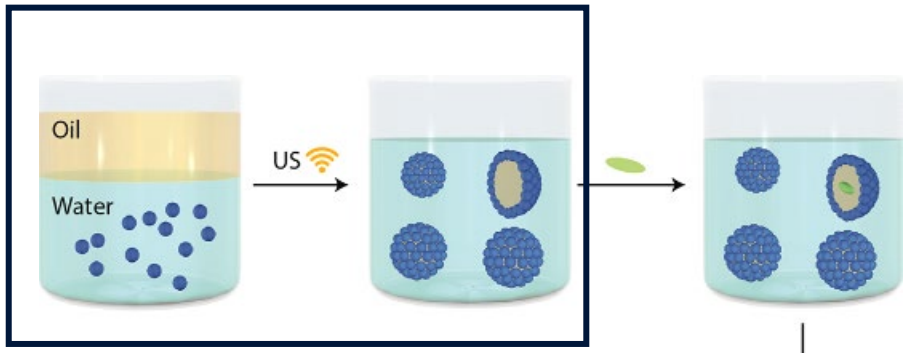
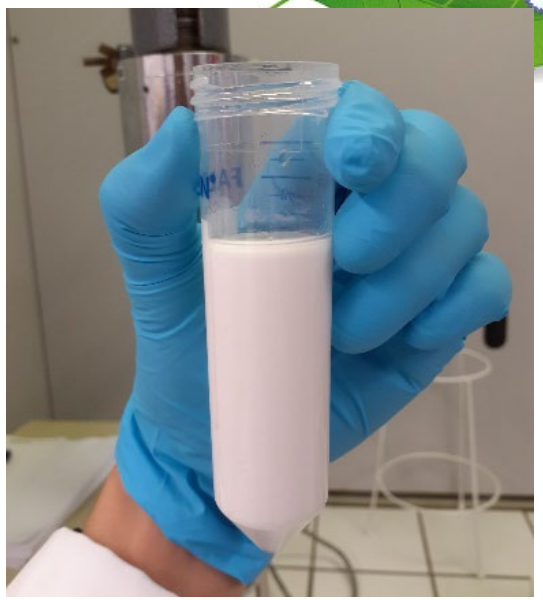
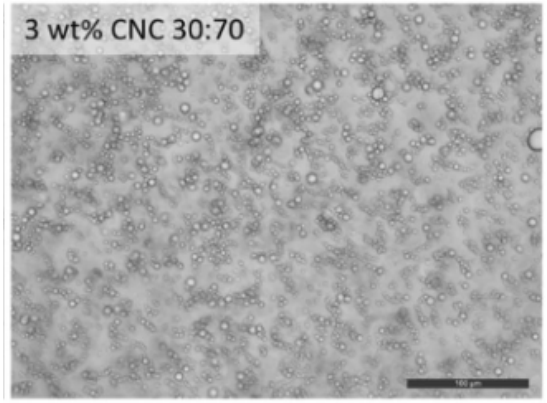
Emulsion Formulation



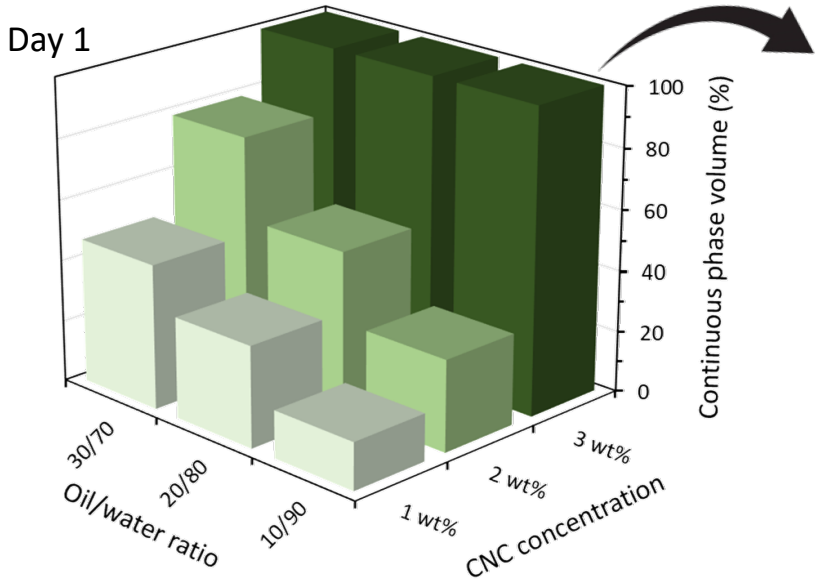


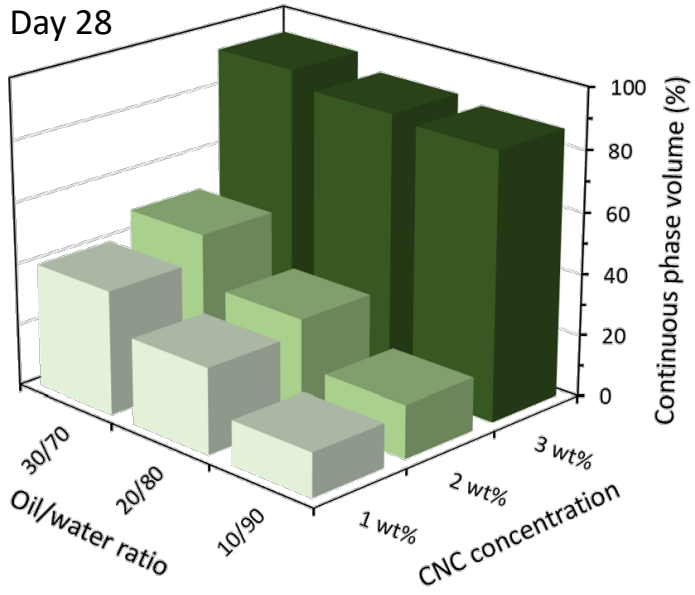
Maximize emulsion stability

- Biopolymer concentration ↑
- Oil:water ratio ↑
- Oil type ↔



CNC-stabilized Canola oil-in-water emulsions





N. Yaakov et al. *ACS Omega* **2018** *3*, 14294-14301
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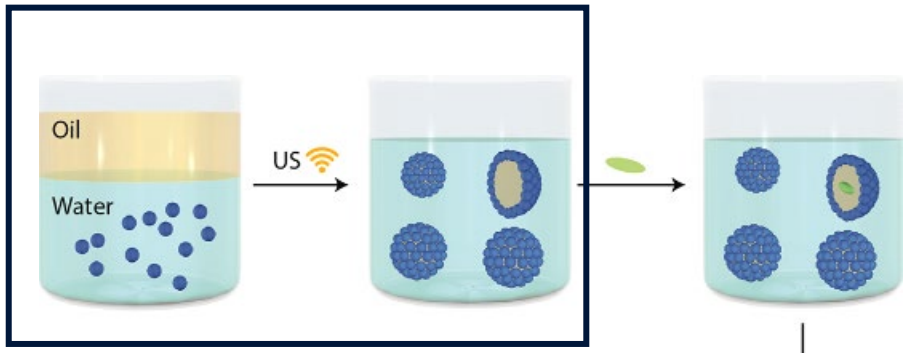
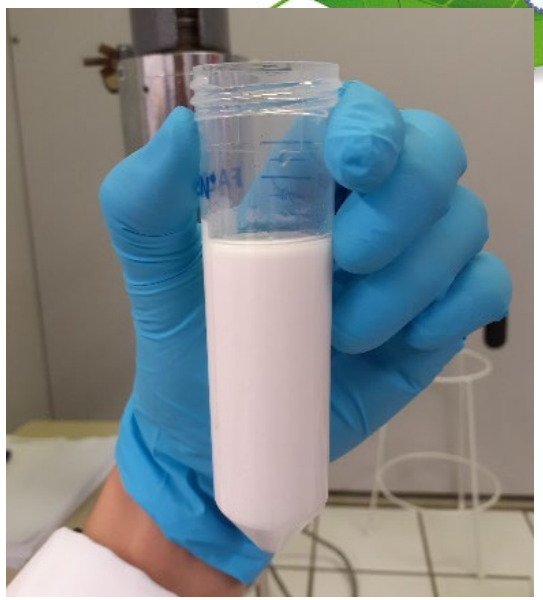
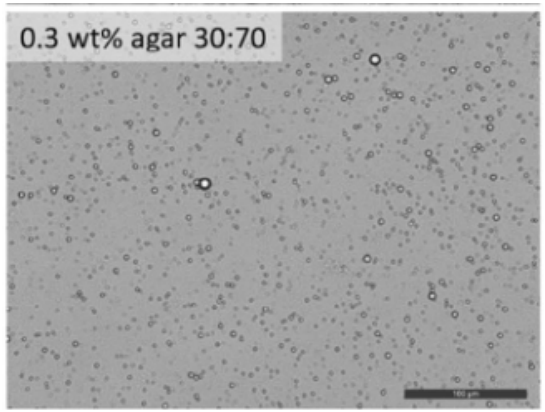
Emulsion Formulation



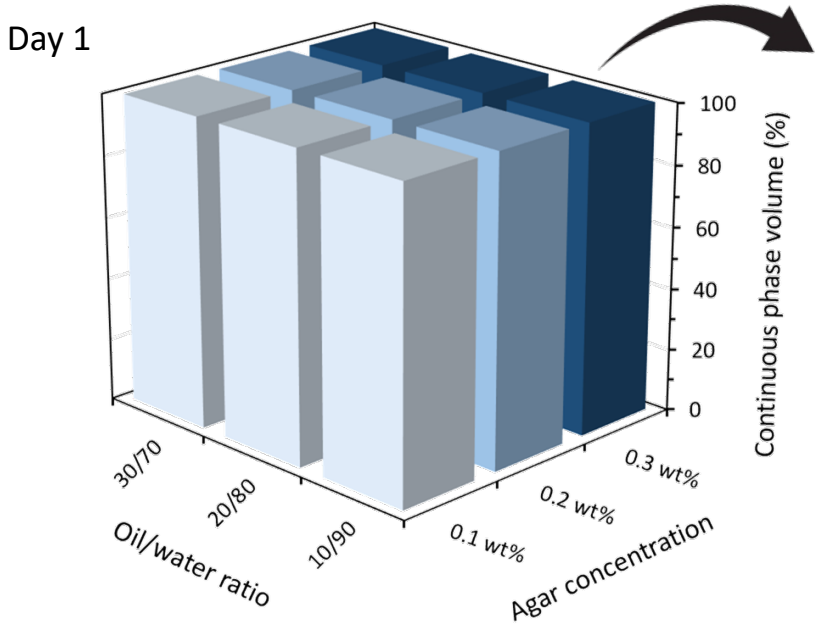


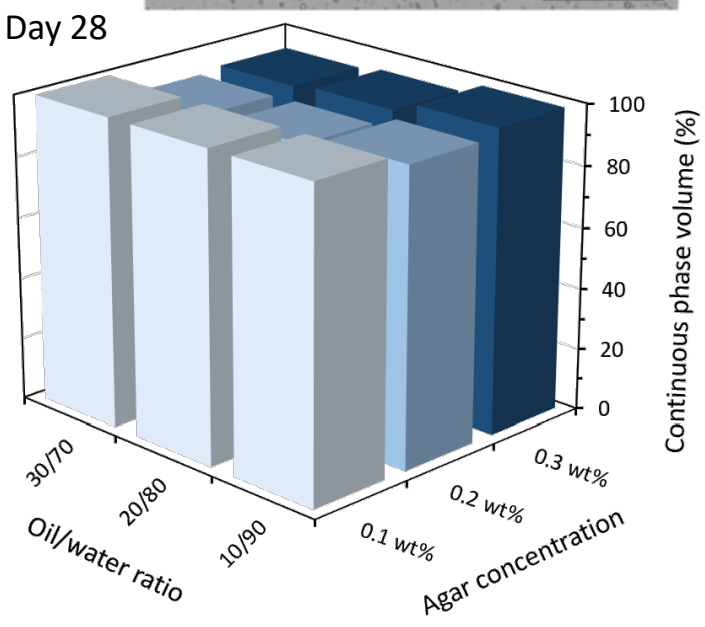
Maximize emulsion stability

- Biopolymer concentration
- Oil:water ratio
- Oil type



Agar-stabilized Canola oil-in-water emulsions





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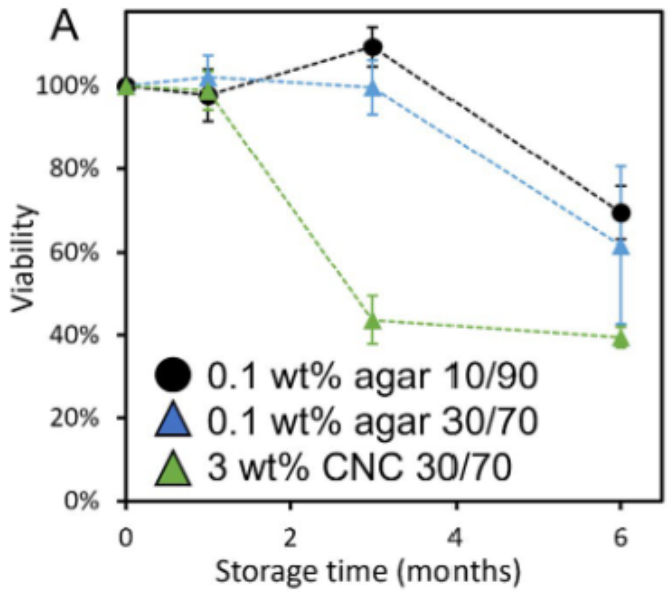
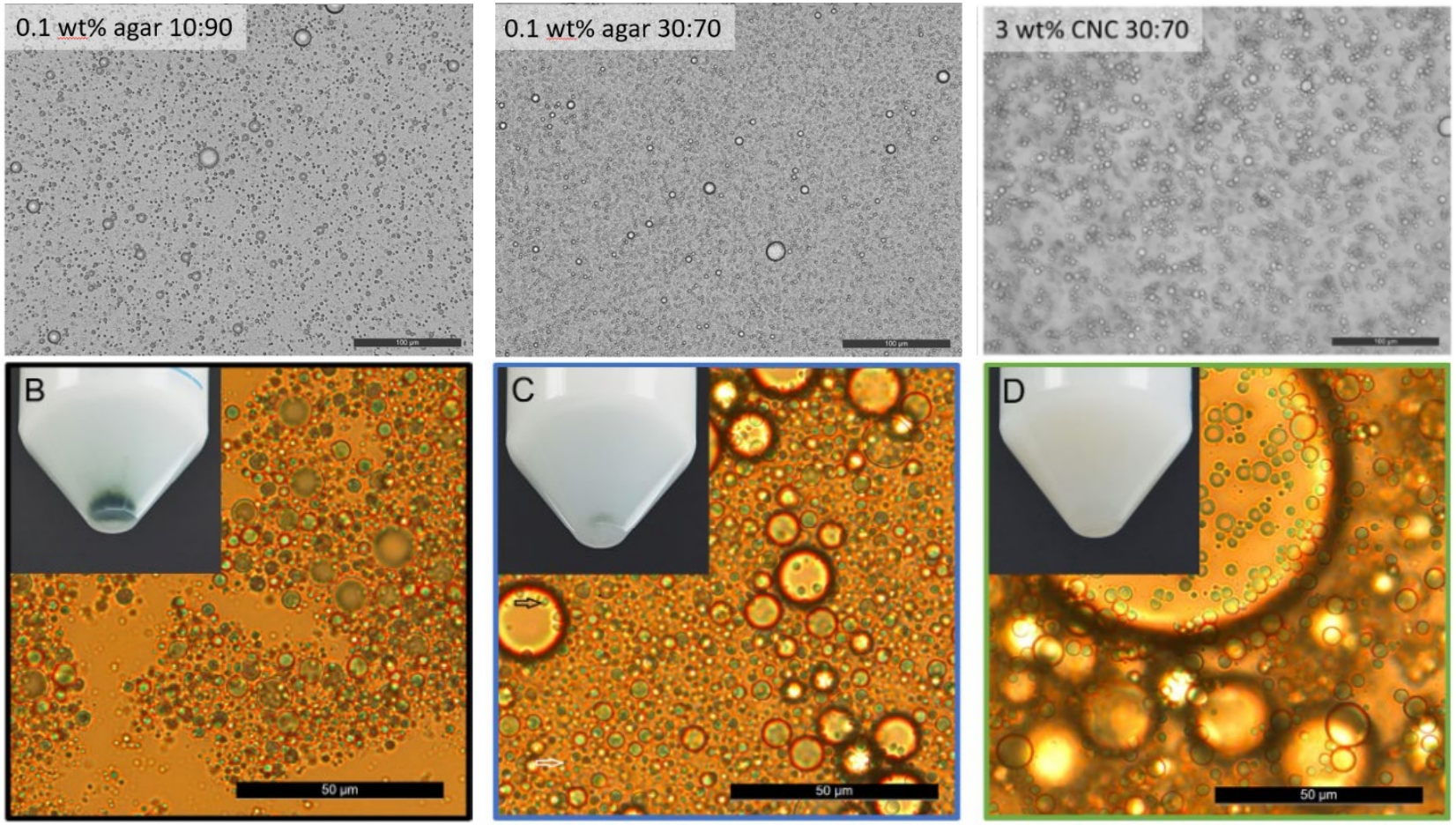
Trichoderma encapsulation

Vortex mix post-emulsification

- Slight increase in droplet size
- Some sedimentation in agar-stabilized formulations





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Conclusions

- CNC and (in particular) agar are effective stabilizers of *Trichoderma* conidia
- Agar-based emulsion formulations remained stable for up to 6 months and were able to encapsulate viable conidia (100% at 3 mo., ~70% at 6 mo.)

Langmuir **2016**, 32 (30)

Chem. Mat. **2017**, 29 (11)

Adv. Health. Mat. **2018**, 7 (1)

Mat. Today **2020**, 37

Adv. Mat. **2021**, 33 (28)

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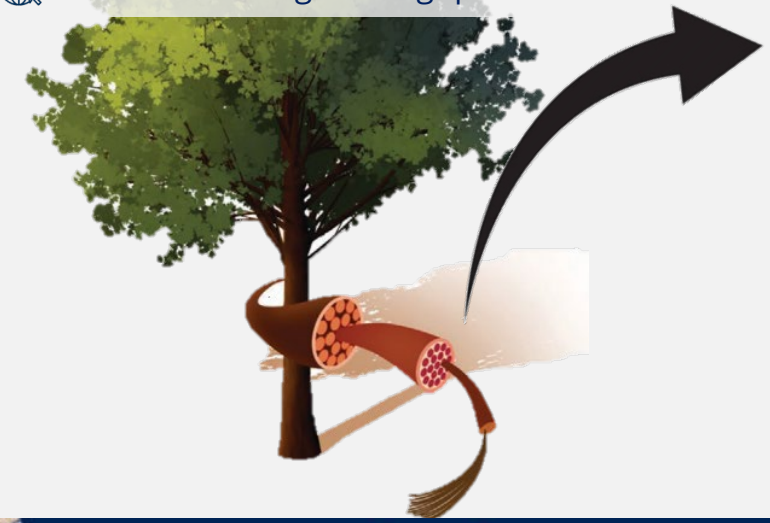

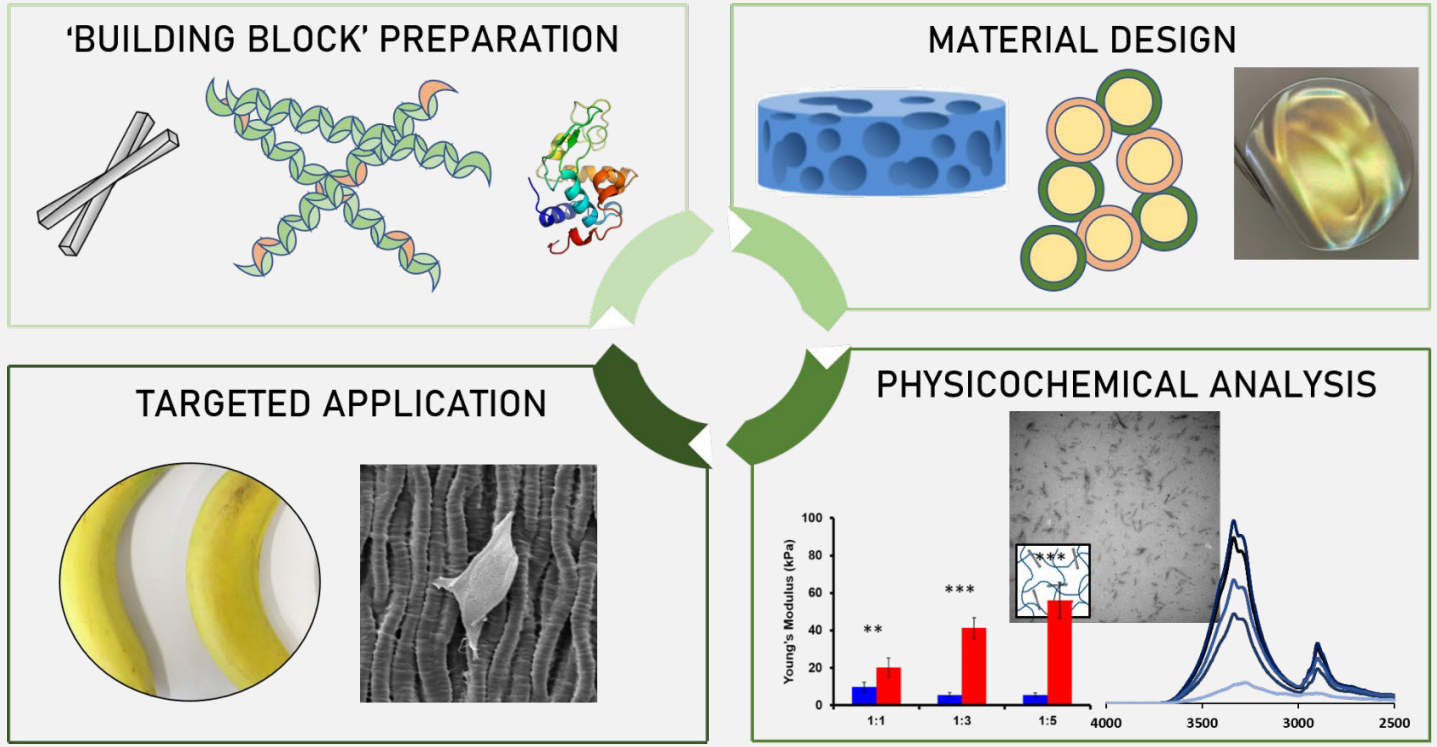

7th in the world

2022 Times Higher Education Impact Rankings

Acknowledgements

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