LIÈGE université
Gembloux
Agro-Bio Tech

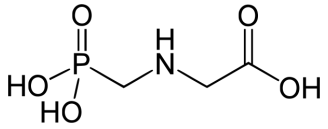
ICMR
Institut de Chimie Moléculaire de Reims
UMR CNRS 7312

# Essential oil encapsulation for pesticide with controlled release

Chloé Maes
Workshop EOs 18/10/2019

# Context

Lot of toxic and polutant pesitcide

Glyphosate 

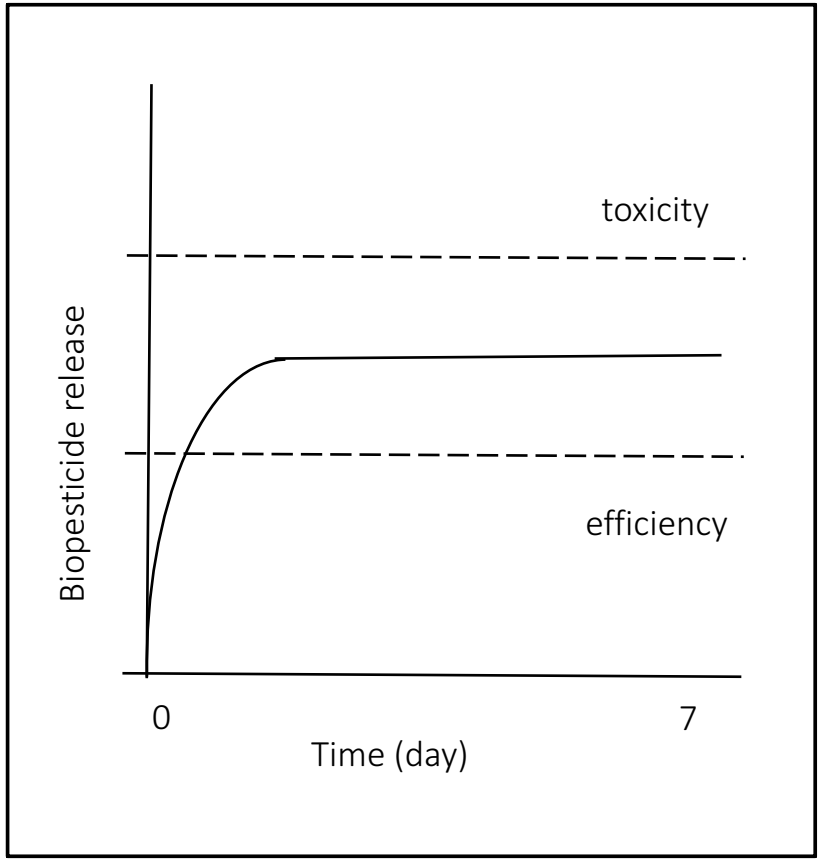

**Bruggen, V., & Jr, J.** (2017) *Science of the Total Environment*, *616617*, 255–268.

Need to preserve agricultural yield

→ Alternatives to synthetic pesiticides

# Introduction

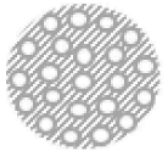
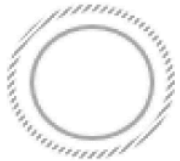
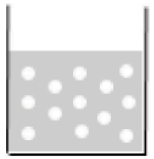
- Essential oil
  - volatile products
  - various extractions methods
  - composition's variation
  - natural biological activities
- Controlled release
  - control volatility
  - depend on application
  - pesticide case



# EOs encapsulation techniques

- Emulsification
- Coarcevation
- Spray drying
- Complexation
- Ionic gelation
- Nanoprecipitation
- Film hydration method
- Active film

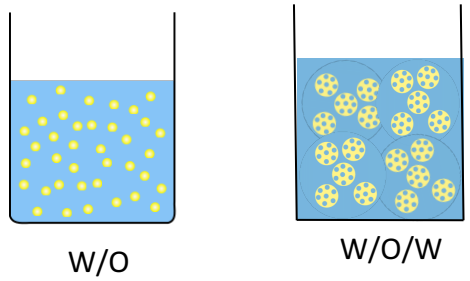
Micro- (1 – 1000 µm) or Nano (< 1 µm)

| | |
|---|---|
|  | Particles: matrix where EOs are dispersed |
|  | Capsules: a membrane surrounds a core where are the EOs. |
|  | Complexes: spatial disposition into an open structure |
|  | Droplets: fine bubbles of the products dispersed in the solvent |

# Essential oil encapsulation techniques

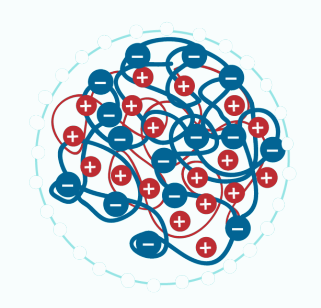
1) Emulsification

- Simple (O/W): stirring of an organic and aqueous phase with emulsifier
  → Liquid (droplets)
  Matrices used: vegetal oil
- Multiple (W/O/W): two successive emulsions : water in oil then in water
  → Capsules
  Matrices used: alginate




2) Coarcervation

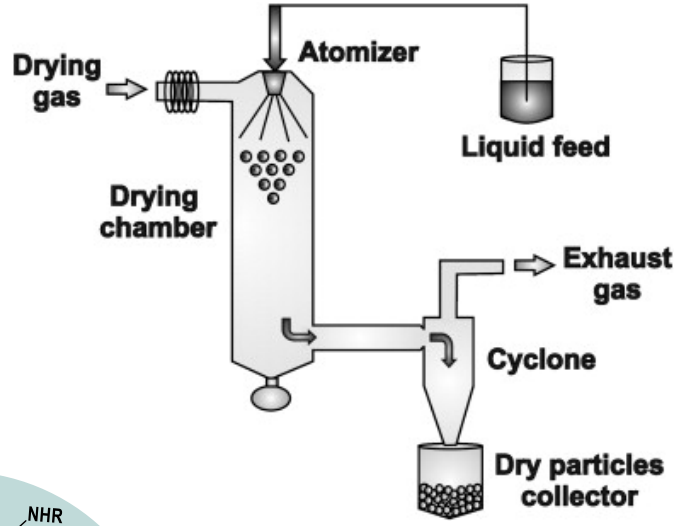
- Simple: addition of a polar phase in a polymer solution
  → Capsules (coacervates)
  Matrices used: alcohol and gelatin solution
- Complexe: disperse and stirre two polymers solution and terminate by a reticulation with an agent EO
  → Capsules
  Matrices used: gelatin, arabic gum and sodium tri-polyphosphate



# Essential oil encapsulation techniques

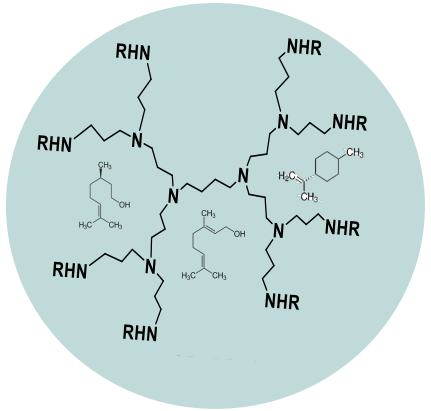
3) Spray drying

- Emulsion O/W is atomized by hot air steam in a spray dryer
  → Particles
  Matrices used: arabic gum, inulin, chitosan,




4) Complexation

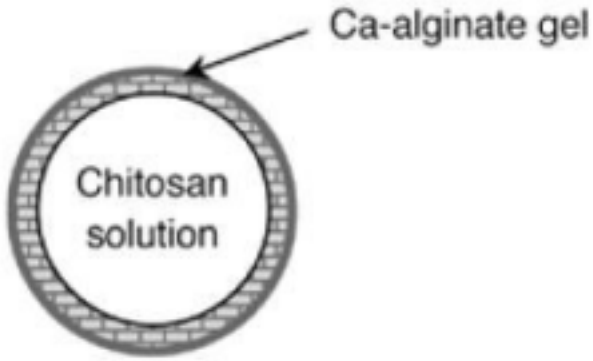
- Spontaneous
- Co-precipitation: stirring, cooling and filtering
- Freeze-drying: assemble and freeze-drying
  → Complex
  Matrices used: β-cyclodextrins, dendrimers



# Essential oil encapsulation techniques

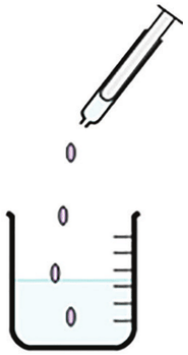
5) Ionic gelation

- Emulsion O/W followed by crosslinking
  → Particles
  Matrices used: alginate, chitosan
  Crosslinkers: calcium chloride, pantasodium tripolyphosphate (TPP) and sodium hexametaphosphate (HMP)




6) Nanoprecipitation

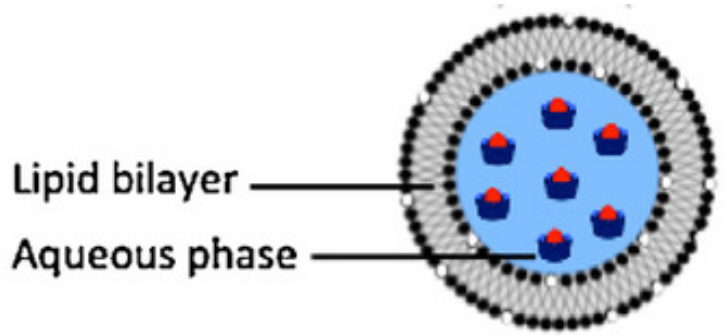
- Addition of aqueous phase in alcohol phase
  → Particles
  Matrices used: Chitosan



# Essential oil encapsulation techniques

7) Film hydration method

- Prepare liposome by stirring EO with phospholipids and cholesterol followed by trapping method with divalent cation
  → Cochleates, vesicules
  Matrices used: lipids and calcium chloride




8) Active film

- Emulsion, ionic gelation and add of a plasticizer
  → film
  Matrices used: alginate, calcium carbonate and sorbitol

# Particular candidates to encapsulate EOs in order to facilitate a controlled release

Release study : - target bioactivity (in vitro or in situ)
- quantitative method (GC-MS)

| Alginate | Chitosan | Cyclodextrins |
|---|---|---|
| - multiple emulsion<br>- ionic gelation ("egg-box" structure) :<br>→ burst effect and steady state (24h)<br>- active film<br>- spray drying<br>→ constant release (50h) | - nanogel mediated<br>→ 78% released after one week<br>- ionic gelation<br>→ burst effect and steady state (105h)<br>- nanoprecipitation<br>- Spray drying<br>→ 10 days | Complexation:<br>- Kneading<br>- Freeze-drying<br>→ constant release (20 days)<br>- In solution<br>→ exponential asymptote |

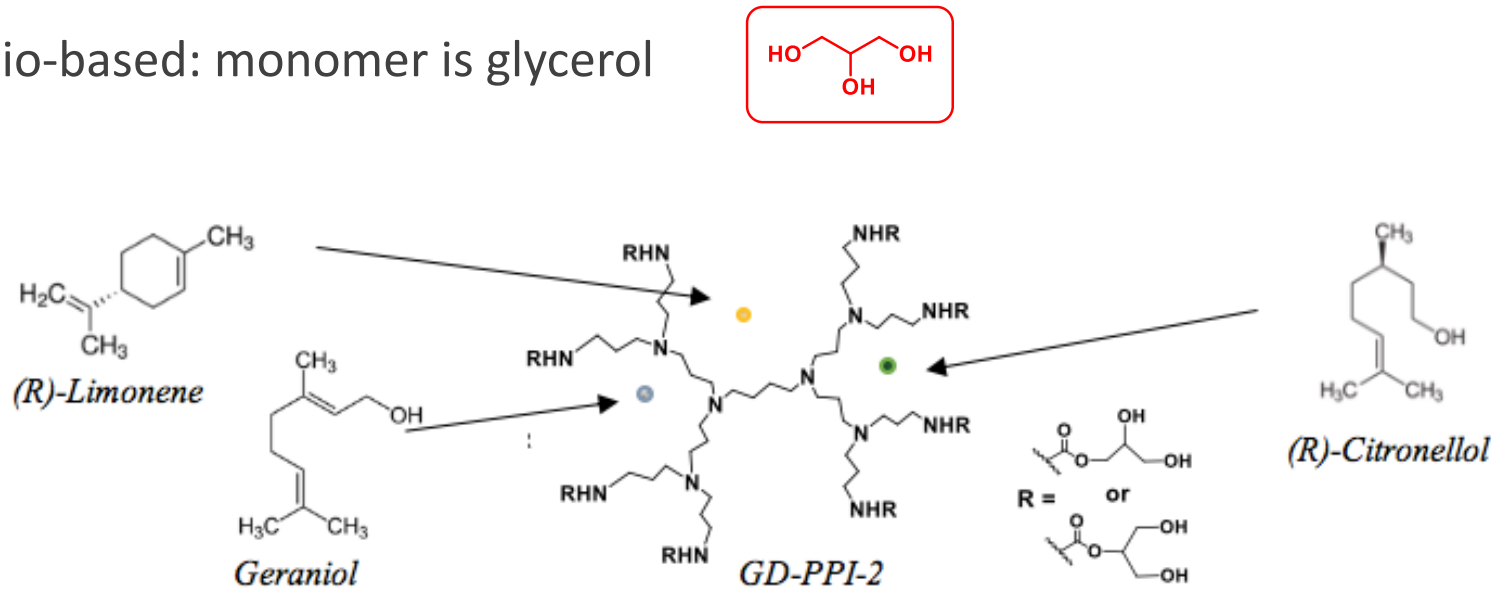
# Particular candidates to encapsulate EOs in order to facilitate a controlled release

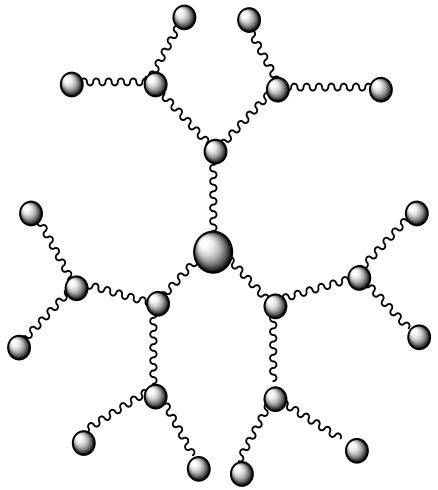
Dendrimers

Tree structure → complexation candidate

Encapsulate organic molecules

Bio-based: monomer is glycerol



# Conclusion

Methods

Matrices

Way to study controlled release

How it works

Influencing factors

Improve following application

# Thank you for your attention

LIÈGE université
Gembloux
Agro-Bio Tech

ICMR
Institut de Chimie Moléculaire de Reims
UMR CNRS 7312

More information:
Maes, C.; Bouquillon, S.; Fauconnier, M.-L. Encapsulation of Essential Oils for the Development of Biosourced Pesticides with Controlled Release: A Review. *Molecules* **2019**, *24*, 2539.

Chloe.maes@uliege.be