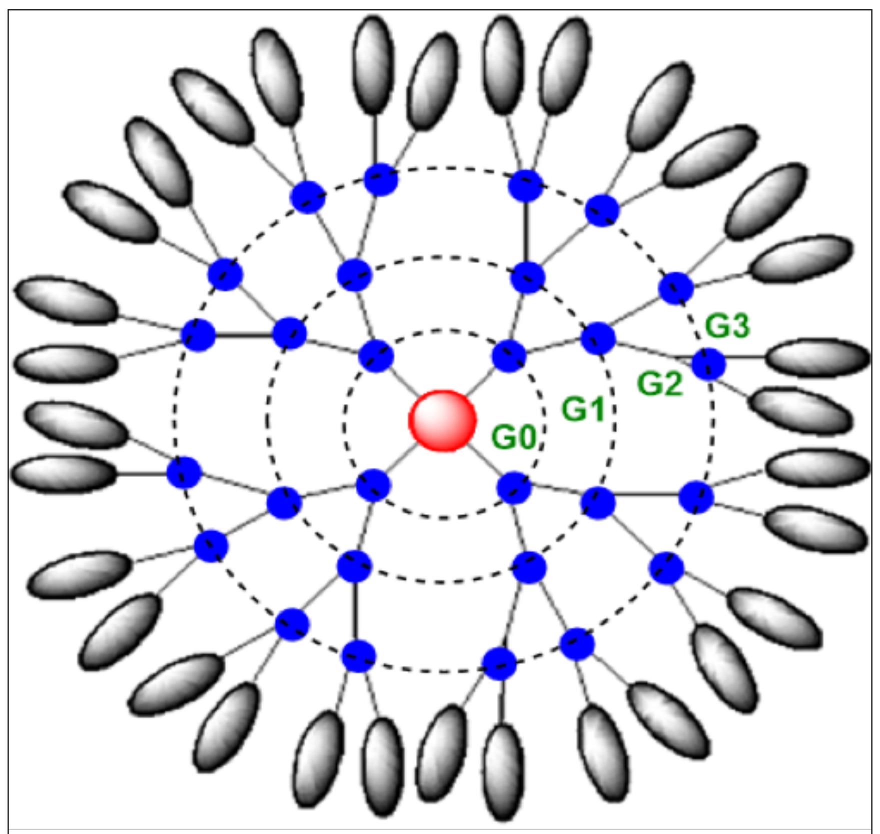
Encapsulation of Cymbopogon winterianus Jowitt and Cinnamomum verum Presl essential oils with glycerodendrimers in order to create a biosourced herbicide

Chloé Maes[*,**], Sandrine Bouquillon[*], Marie-Laure Fauconnier[**]

[*] Institut de Chimie Moléculaire de Reims, UMR CNRS 7312, Université Reims-Champagne-Ardenne, UFR Sciences, BP 1039 boîte 44, 51687 Reims Cedex 2, France
[**] Gembloux Agro-Bio Tech, Université de Liège, 2 Passage des Déportés, 5030 Gembloux, Belgique

Dendrimer structure



- Polyfonctional core
- Branching units
- Terminal groups

Context

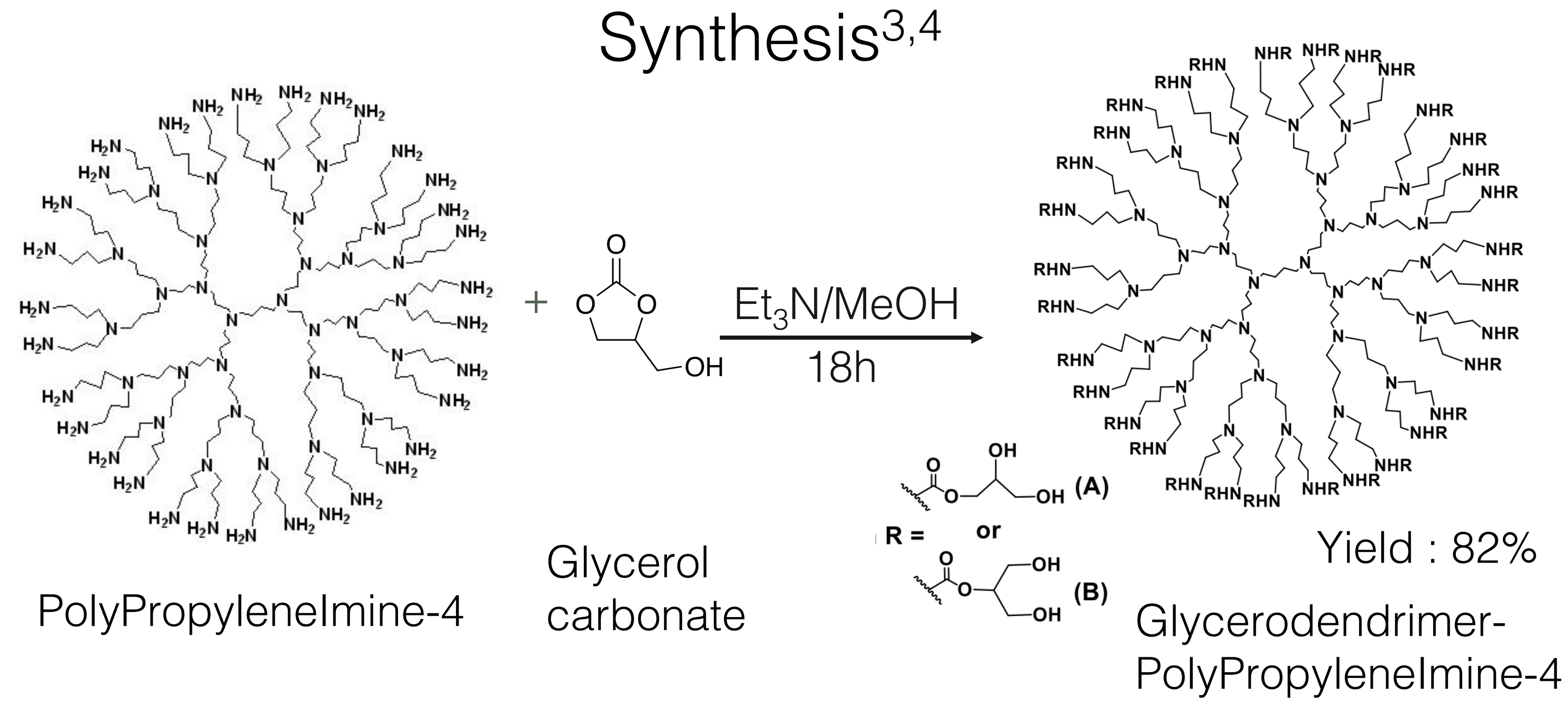
Nowadays, the risks coming from the use of pesticides are one of the major controversies. Indeed, more and more environmental and public health problems are detected following the use of these products[1]. Essential oils are prime candidates to create green alternatives. However, the high volatility of these compounds involve to encapsulate them to ensure a slow and controlled release. A certain number of encapsulation techniques have already been developed but none of them meets the requirements of field application. This is where our work begins. The innovative encapsulation of essential oils is realized using dendrimers, which are macromolecules with a tree structure giving them a high encapsulation capacity. In addition, the specimens used in this study contain a moiety with a natural origin: glycerol.

Objectives

In a first step, the encapsulation capacity of different dendrimers was studied. Then, the optimal conditions of the reaction and a complete analysis of the interactions between the dendrimers and the essential oils were carried out. In a second step, a kinetic study of the release of each system will be performed, the biological activity will be evaluated to finally formulate an effective green pesticide.

Results

Synthesis[3,4]



Encapsulation: DHS-GC-MS

1. Yield of total retention[2]

$$r(\%) = \left(1 - \frac{\sum A_D}{\sum A_0}\right) \times 100$$

A_D = Area with dendrimers
A_0 = Area without dendrimers

2. Retention rate by external calibration

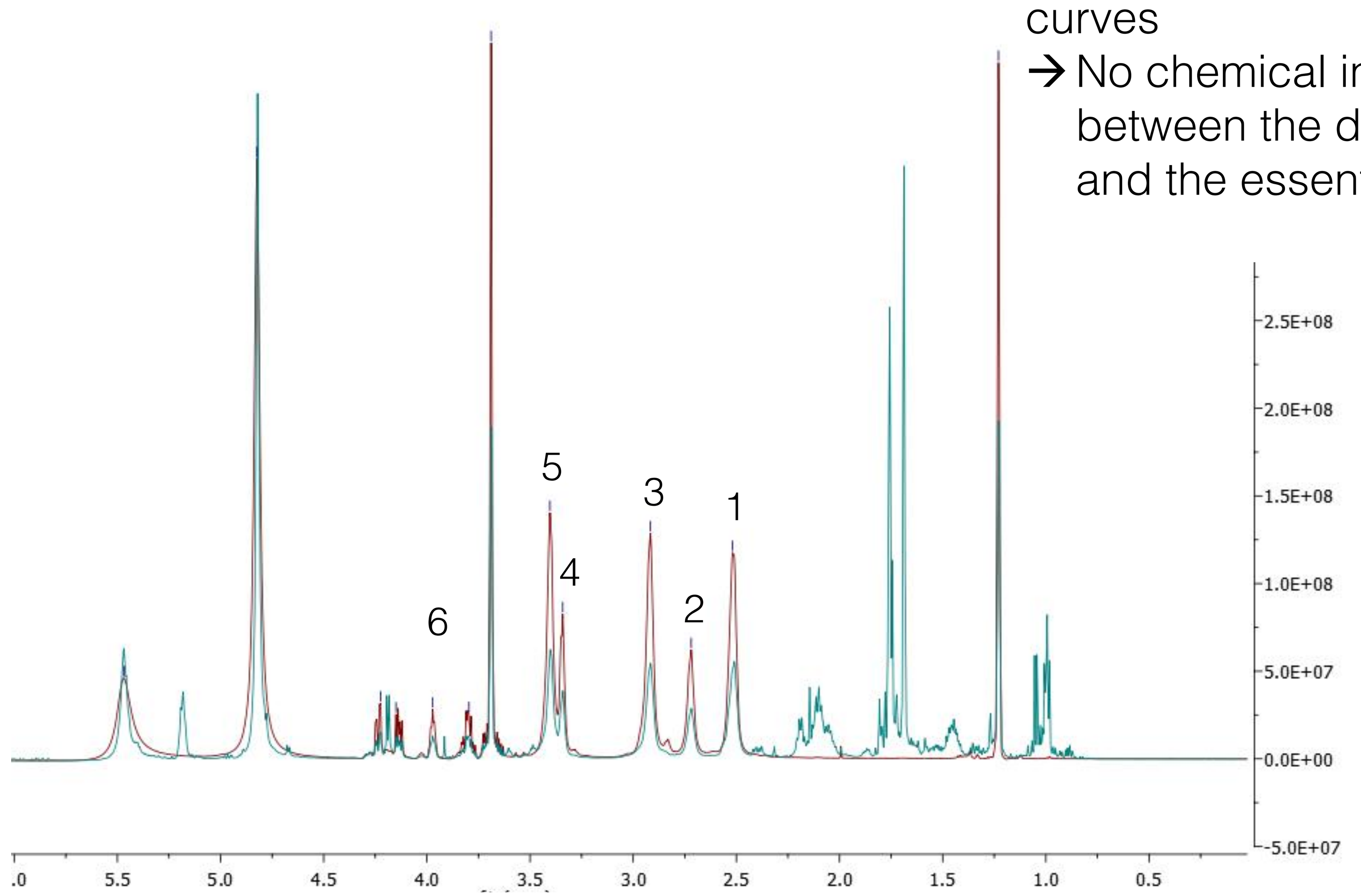
Dendrimer	Citronella EO	Cinnamomum EO
GD-PPI-1	-12,37 +/- 0,97	24,35 +/- 4,23
GD-PPI-2	3,09 +/- 1,95	14,15 +/- 3,77
GD-PPI-3	26,65 +/- 5,77	25,99 +/- 4,36
GD-PPI-4	10,55 +/- 3,53	24,21 +/- 3,95
GD-PAMAM-0	9,83 +/- 0,44	12.17 +/- 0,41
GD-PAMAM-1	6,49 +/- 0,72	29,01 +/- 0,68
GD-PAMAM-2	24,88 +/- 4,80	38,84 +/- 0,57
GD-PAMAM-3	20,39 +/- 2,38	32,97 +/- 1,13

— Best generations

Interaction: RMN

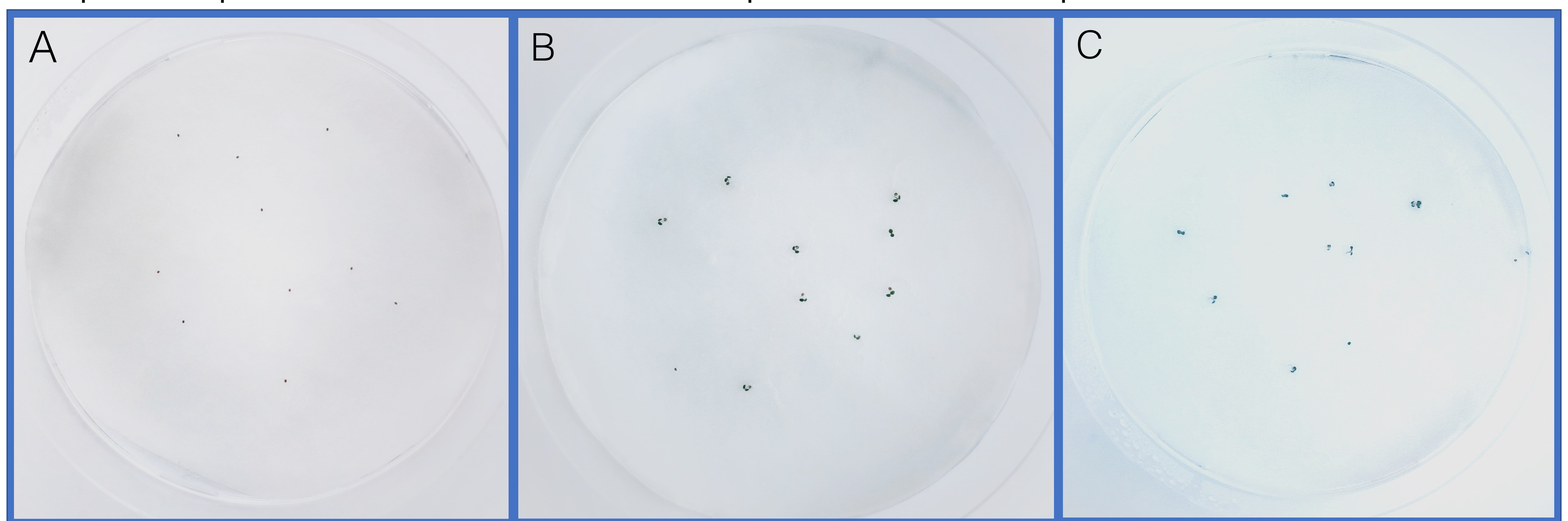
Superposition of ^{1}H RMN spectra
red curve: GD-PAMAM-2 alone (peaks 1-6)
blue curve: GD-PAMAM-2 encapsulating citronella EO

NO SHIFT between both curves
→ No chemical interaction between the dendrimer and the essential oil



Germination inhibition

Tests of germination inhibition have shown the interest in citronella and cinnamon EOs as germination inhibitors. In addition, dendrimers alone do not interfere on the seeds growing but allow the work of EOs. Next step is to prove the interest of encapsulation in a opened environment.



A. Sample* treated with 20 mg citronella EO encapsulated in a 2mM aqueous solution of GD-PPI-3
B. Sample* treated with water
C. Sample* treated with a 2mM aqueous solution of GD-PPI-3

* 10 *Arabidopsis thaliana* (L.) Heynh. seeds in petri dish with paper filter; treated with 2mL of solution, closed and incubate 5 days in grow room (16:9 ; 20°C)

Conclusion

This study shows that essential oil encapsulation by dendrimers is possible and is different following their size. The best generation for each dendrimer type is kept for an optimization of the encapsulation conditions to increase retention yield. RMN analysis show that it is no chemical interaction that allow the retention, but it is probably more physical interactions. Germination inhibition tests realized with the essential oil-dendrimer system confirm the interest of essential oil for bio-based pesticide.

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Contact :
chloe.maes@univ-reims.fr

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