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Chitosans and cyclodextrin polymers to design new antifungal coatings

AUTHORS

Anne LORON / LCPO, 16 AVENUE PEY BERLAND, PESSAC
Véronique COMA / ABORATOIRE DE CHIMIE DES POLYMÈRES ORGANIQUES UMR 5629, PESSAC, FRANCE, 16 AVENUE PEY-BERLAND, PESSAC
Christian GARDRAT / LABORATOIRE DE CHIMIE DES POLYMÈRES ORGANIQUES UMR 5629, PESSAC, FRANCE, 16 AVENUE PEY-BERLAND, PESSAC
Vessela ATANASOVA-PENICHON / CENTRE INRA DE NOUVELLE AQUITAINE?BORDEAUX UR1264 MYCSA, INRA, VILLENAVE D'ORNON, FRANCE, 71 AVENUE EDOUARD BOURLAUX, VILLENAVE-D'ORNON
Nicolas TABARY / UNIVERSITÉ LILLE 1, UNITÉ MATÉRIAUX ET TRANSFORMATIONS (UMET) UMR CNRS 8207, VILLENEUVE D?ASCQ, FRANCE, UNIVERSITÉ DE LILLE BÂTIMENT C6, VILLENEUVE D'ASCQ
Bernard MARTEL / UNIVERSITÉ LILLE 1, UNITÉ MATÉRIAUX ET TRANSFORMATIONS (UMET) UMR CNRS 8207, VILLENEUVE D?ASCQ, FRANCE, UNIVERSITÉ DE LILLE BÂTIMENT C6, VILLENEUVE D'ASCQ

PURPOSE OF THE ABSTRACT

CHITOSANS AND CYCLODEXTRIN POLYMERS TO DESIGN NEW ANTIFUNGAL COATING

Introduction

The pathogenic fungus Fusarium graminearum is responsible for the disease Gibberella Ear Rot in maize and Fusarium Head Blight in wheat. The diseases caused by Fusarium not only severely decrease grain yield, but also result in contaminated grains with an unacceptable levels of mycotoxins, which are toxic secondary metabolites. Hence, such fungal strains can drive the outbreaks of mycotoxicosis in humans and animals.
F. graminearum can produce some class B CMR mycotoxins, such as trichothecenes B. To control the fungal development, traditional fungicides may be used but they are not sufficiently efficient on mycotoxin production while being harmful to human health and environment. In consequence, new safer fungicide formulations, especially based on natural antifungal agents, are today critically required. As potential food preservatives, natural extracts such as phenolic compounds and renewable and active polymers such as chitosans (crustacean chitin derivatives, Figure 1) have received lots of attention to prepare new antifungal formulations.
Among all phenolic compounds, tetrahydrocurcumin (THC, Figure 1), one colorless metabolite of curcumin, possesses anti-oxidant, antifungal and anti-carcinogenic properties as curcumin but with a higher radical-scavenging activity. It had already shown good results regarding the mycotoxin production by Fusarium verticilloides.1,2 THC is unfortunately a scarcely water-soluble molecule. To enhance its apparent solubility, we chose to encapsulate the molecule in cyclodextrins, ring-shaped bio-polymers.

Results and discussions

In the present study, the effect of THC was first investigated on the radial mycelium growth of F. graminearum and on mycotoxin production. Both results are very promising, in comparison with other phenolic compounds such as ferulic acid.
For THC solubility enhancement, ?-cyclodextrins (?CD, composed of seven glucose units) were selected for the encapsulation. The resulted inclusion complexes were evaluated on the growth of F. graminearum. Despite the higher THC water-solubility, complexes activated the mycelial growth. To avoid fungal activation, a new system made of polymers of ?-cyclodextrins loaded with THC was studied.3 Preliminary results showed an enhanced

THC solubility as expected and a significant inhibition of the fungal growth (Figure 2).
Finally, some chitosans were selected due to their inherent antimicrobial activities. Various chitosans well-characterized in terms of molecular weight and deacetylation degree were tested against the fungal growth. The cationic biopolymer has proved to have an intrinsic bioactivity, with an IC50 between 0.3 g/L and 1.2 g/L (depending on the chitosan).

Prospects

Chitosans and inclusion complexes of tetrahydrocurcumin into polymers of cyclodextrins demonstrated efficacy to control diseases due to the development of F. graminearum. Experiments regarding trichothecene B mycotoxins are under investigation but first results are promising. A first formulation could be then developed by adding filmogen solution also based on chitosan. This formulation could be further tested on soil microbiota, to ensure that it is not harmful for the soil.

References

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FIGURES

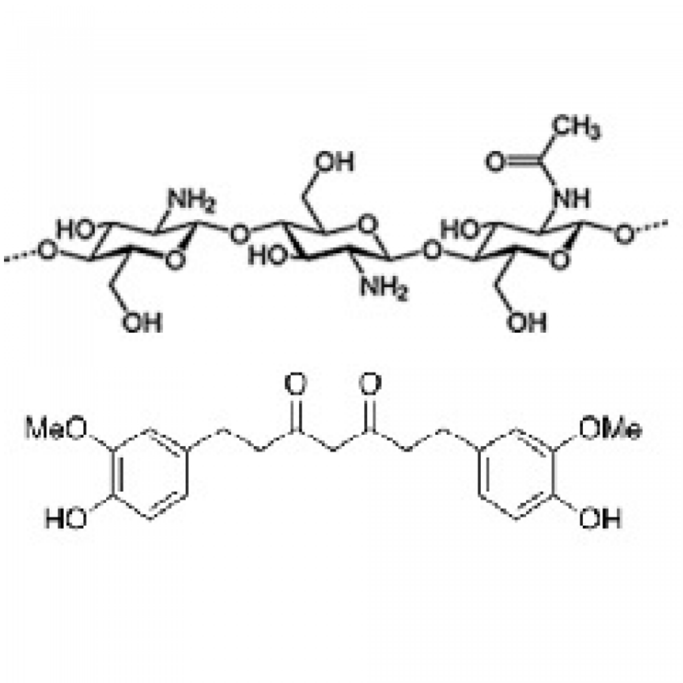

FIGURE 1

Figure 1

Chitosan and THC structure

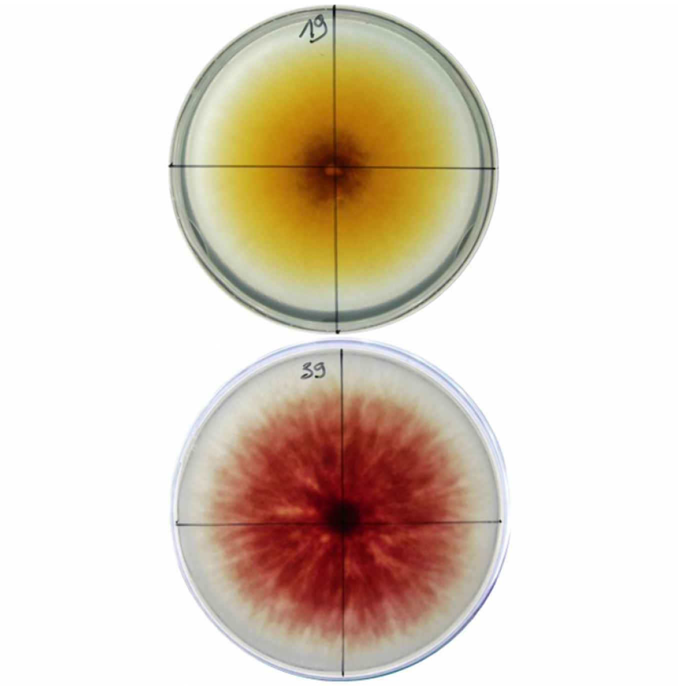

FIGURE 2

Figure 2

Fusarium graminearum CBS 185.32 on PDA medium after 5 days after inoculation, in the dark, at 25°C, relative humidity = 70%

a) supplemented with anionic polymer at 50 g/L and THC

b) control

KEYWORDS

chitosan | Fusarium graminearum | cyclodextrin | tetrahydrocurcumin

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