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Biofungicides based on curcumin derivatives and chitosan coatings inhibit mycotoxin production by Fusarium pathogens

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PURPOSE OF THE ABSTRACT

The pathogenic fungi 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 including deoxynivalenol (DON) and 15-acetyldeoxynivalenol (15-ADON). 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, Fig. 1) have received lots of attention to be use in new antifungal formulations.

Among all phenolic compounds, tetrahydrocurcumin (THC, Fig. 2), 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.i, ii

In the present study, the effect of THC was first investigated on the radial F. graminearum growth and mycotoxin production. Second, to increase the THC solubility into chitosan-based formulations and control its release rate, cyclodextrins were selected as carriers.

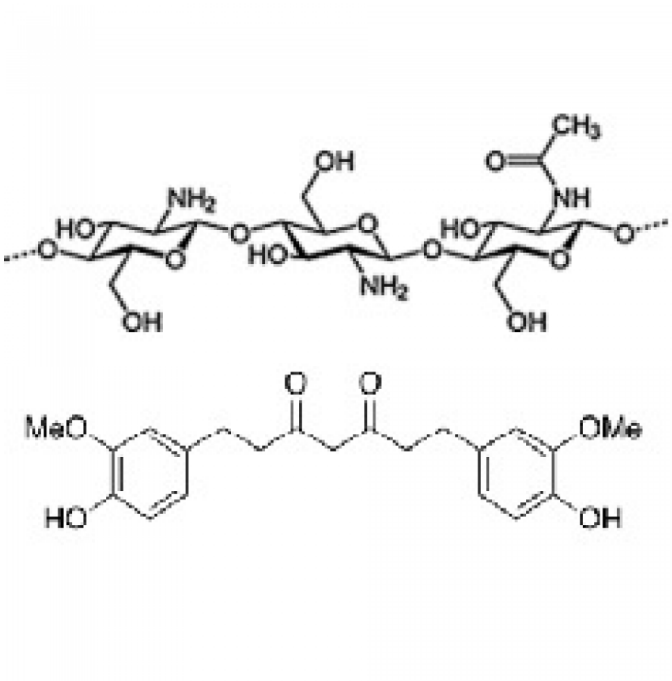
For the bioactivity of THC, the half maximal inhibitory concentration (IC50) was evaluated. The value was 0.5 mM, which is very promising. By contrast, the IC50 of ferulic acid, a well-known antifungal agent, was about 1.5 mM. In addition, more than 80% of mycotoxin production can be inhibited with just 0.01 mM of THC. As a further comparison, ferulic acid at 0.5 mM, just decreased the toxins accumulation about of 19-33%, depending on the toxins.

THC is unfortunately a scarcely water-insoluble molecule. To enhance the apparent solubility ?-cyclodextrins (?CD) or randomly-methylated-?-cyclodextrins (Me?CD) -two ring-shaped bio-polymers composed of seven glucose units- were selected. The resulted inclusion complexes were tested and the effect on the growth of F.

graminearum was evaluated. Despite THC solubility enhancement of 10 times for ?CD and of 100 times for Me?CD, both complexes activated the mycelial growth. This was probably due to a metabolization of the sugar derivatives by the fungi, whose growth cannot be counter-balanced by THC presence in our conditions. To avoid fungal activation, a new system made of polymers of ?-cyclodextrins loaded with THC was studied.
?-cyclodextrins polymers were obtained using citric acid as cross-linker agent under mild conditions. They had already been employed as solubilizing agents of a lot of insoluble active compounds in several applications.[iii] Preliminary results showed an enhanced THC solubility as expected and a significant inhibition of the fungal growth.

Finally, to achieve total fungal growth inhibition, some chitosans were selected due to their inherent antimicrobial activities. Combined with their film forming properties, chitosans could play the role of an active coating matrix, loaded with THC/polymer ?CDs inclusion complexes, providing the controlled and long-lasting release of THC.

FIGURES



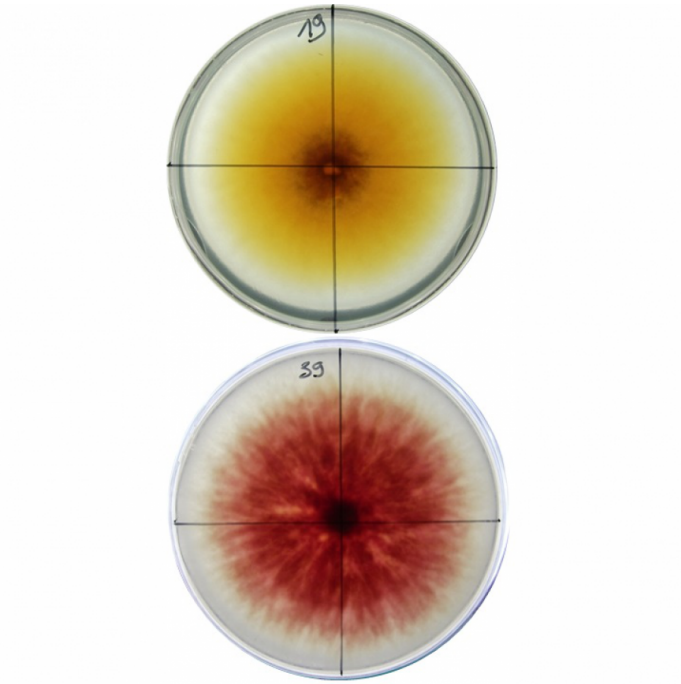


FIGURE 1

Figure 1

Chitosan and tetrahydrocurcumin structures

FIGURE 2

Figure 2

KEYWORDS

curcumin derivatives | chitosans | Fusarium graminearum | cyclodextrins

BIBLIOGRAPHY

i Coma V., Portes E., Gradrat C., Richard-Forget F., Castellan A. Food Additives & Contaminants: Part A, 2011. 28, 218–225

ii Portes E., Gardrat C., Castellan A., Coma V. Carbohydrate Polymers, 2009, 76, 578-584

iii García-Fernández M.J., Tabary N., Martel B., Cazaux F., Oliva A., Taboada P., Concheiro A., Alvarez-Lorenzo C. Carbohydrate Polymers, 2013, 98, 1343-1352