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Mesoporous silica nanoparticles for the encapsulation of essential oils and the improvement of their activity against *Fusarium avenaceum* and its production of enniatins

Despite the in vitro efficacy of various essential oils (EOs), their practical use to control toxigenic *Fusarium* spp is limited by their high volatility and sensitivity to UV and oxidation. Their nano-encapsulation can provide protection for the active volatile molecules and allow for a gradual release into the environment. Mesoporous silica nanoparticles (MSNPs) are inert, mechanically stable, stable in suspension in an aqueous medium and their specific surface area is very suitable for functionalization. We have used them for the encapsulation of EOs with antifungal and antimycotoxin activity

Mesoporous silica nanoparticles synthesis

Sol-gel Method

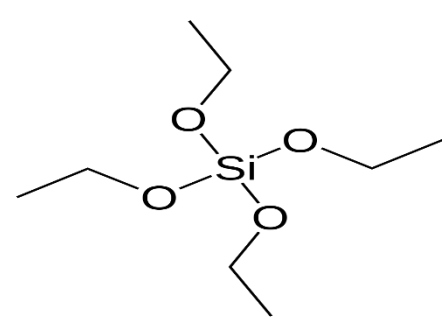
Precursor:

tetraethyl orthosilicate (TEOS)

Surfactants:

Cetyl trimethyl ammonium bromide (CTAB)

Pluronic P123 (P123)



Essential oil encapsulation using impregnation

EOs : Hydrodistillation of *Thymus capitatus* (TC) and *Ammoides pusila* (AP) [aerial parts]

EOs dissolution in hydroalcoholic solution

Addition drop by drop to MSNPs

Evaporation of the solvent at room temperature

Caracterisation of the nanoproducts

N2 physisorption measurements at 77K:

* Specific surface area: Brunauer-Emmett-Teller (BET)

* Pore size distribution: Barrett-Jorner-Halenda (BJH)

Thermogravimetric Analyse

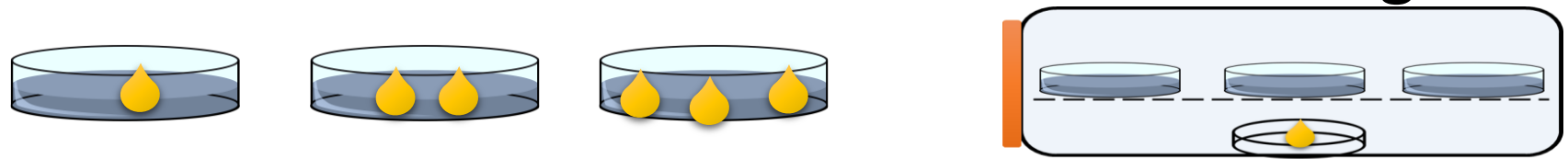
In vitro release of EO in liquid and evaporation

Evaluation of antifungal (*F. avenaceum*) and antimycotoxins (enniatiens) activities

Cultures in FDM-Agar medium, 25°C, 10 j

Contact

Fumigation



Mycelial growth



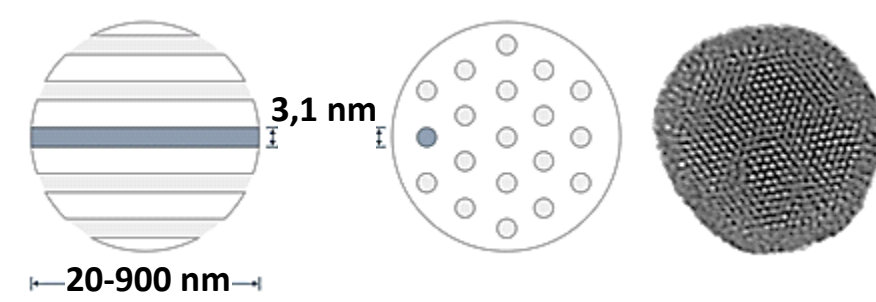
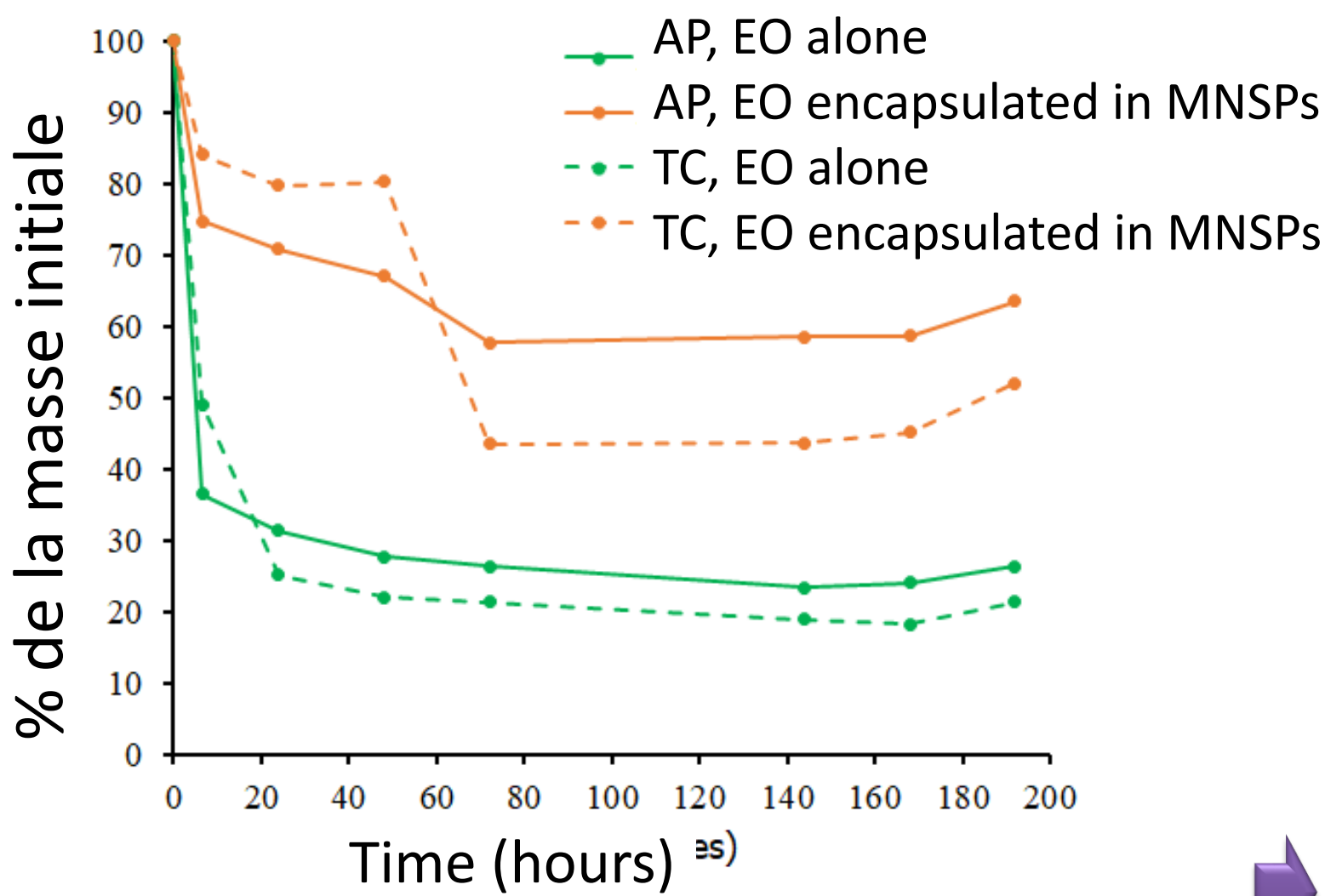
Measures

Enniatins B1+B2+B3 (ENNs)
In Agar- UPLC-DAD



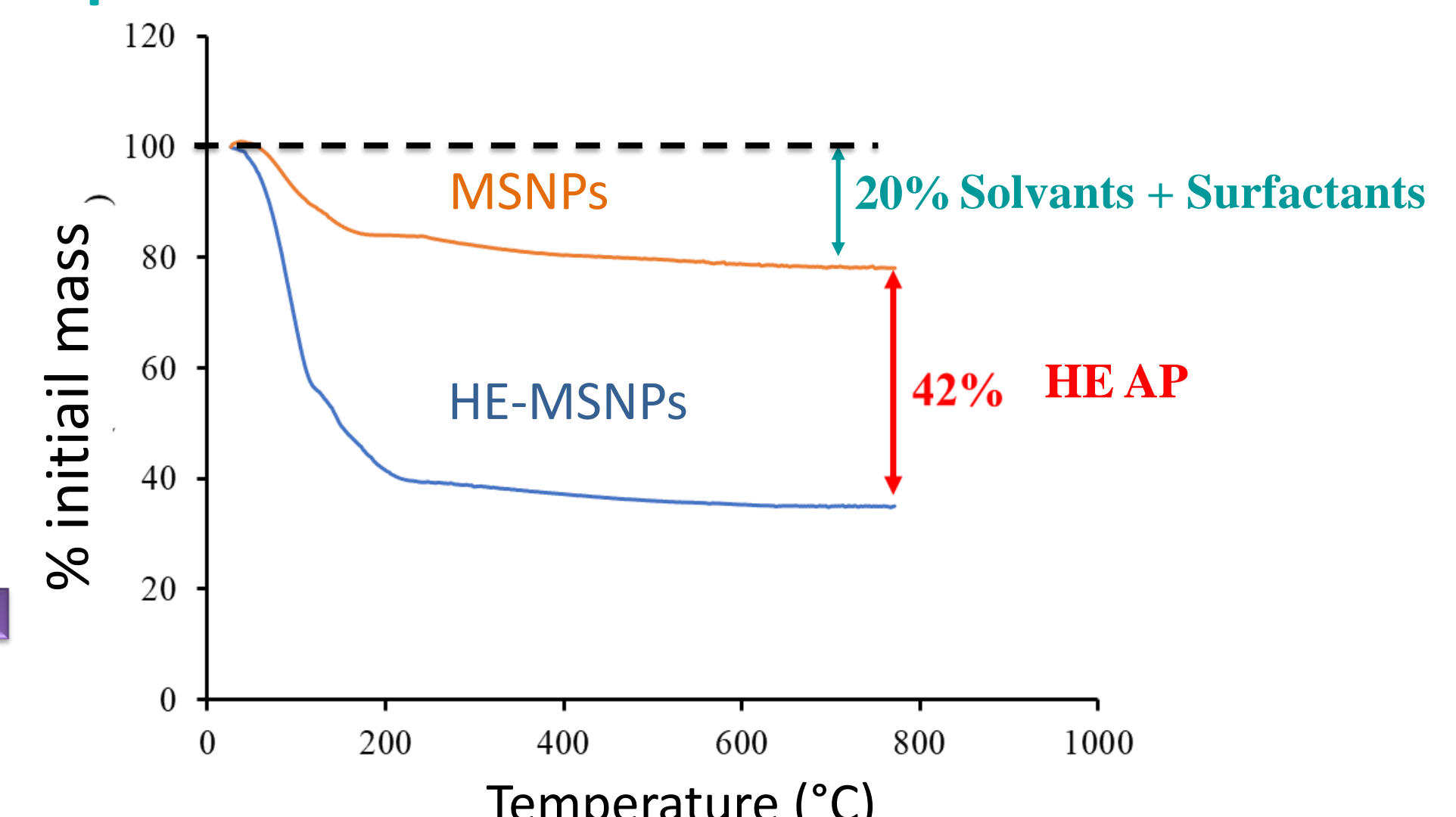
Chakroun et al. 2021, Molecules . <https://doi.org/10.3390/molecules26226906>

Mesoporous silica nanoparticles characterization and yield of HEs' encapsulation



Confirmation of the mesoporous structure
Specific surface area = 486,97 m² g⁻¹
Mean por size: 3,1 nm

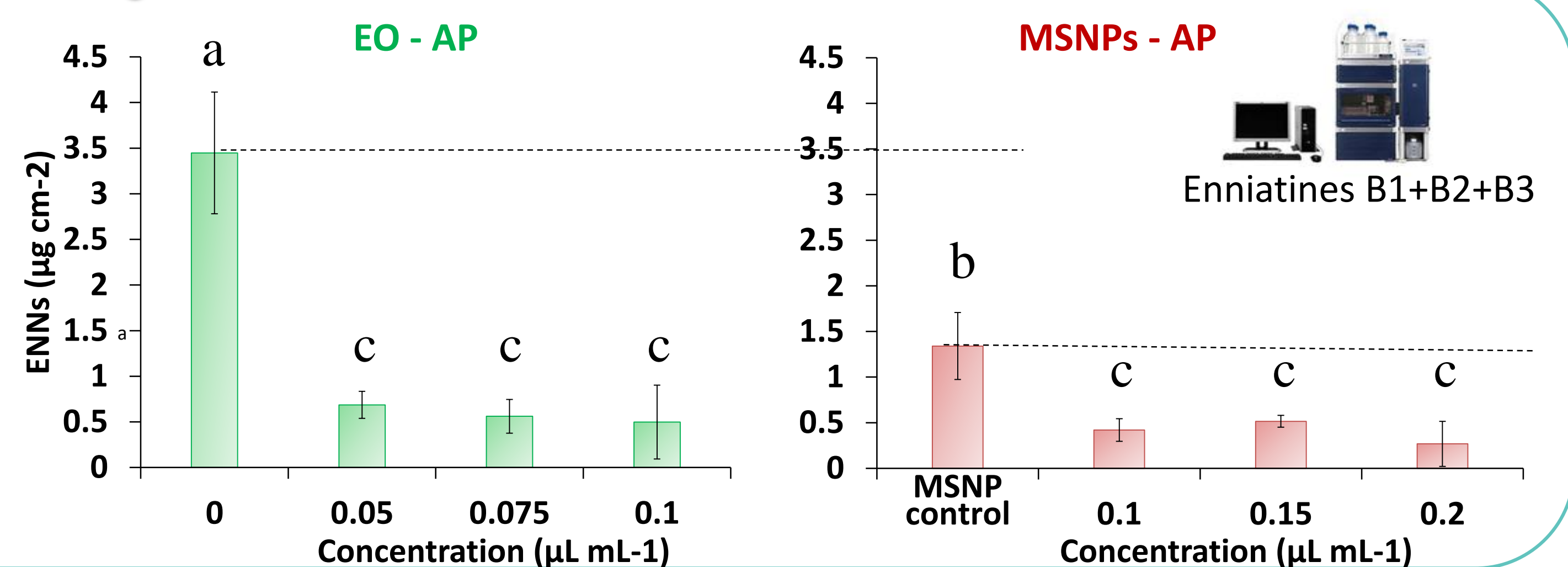
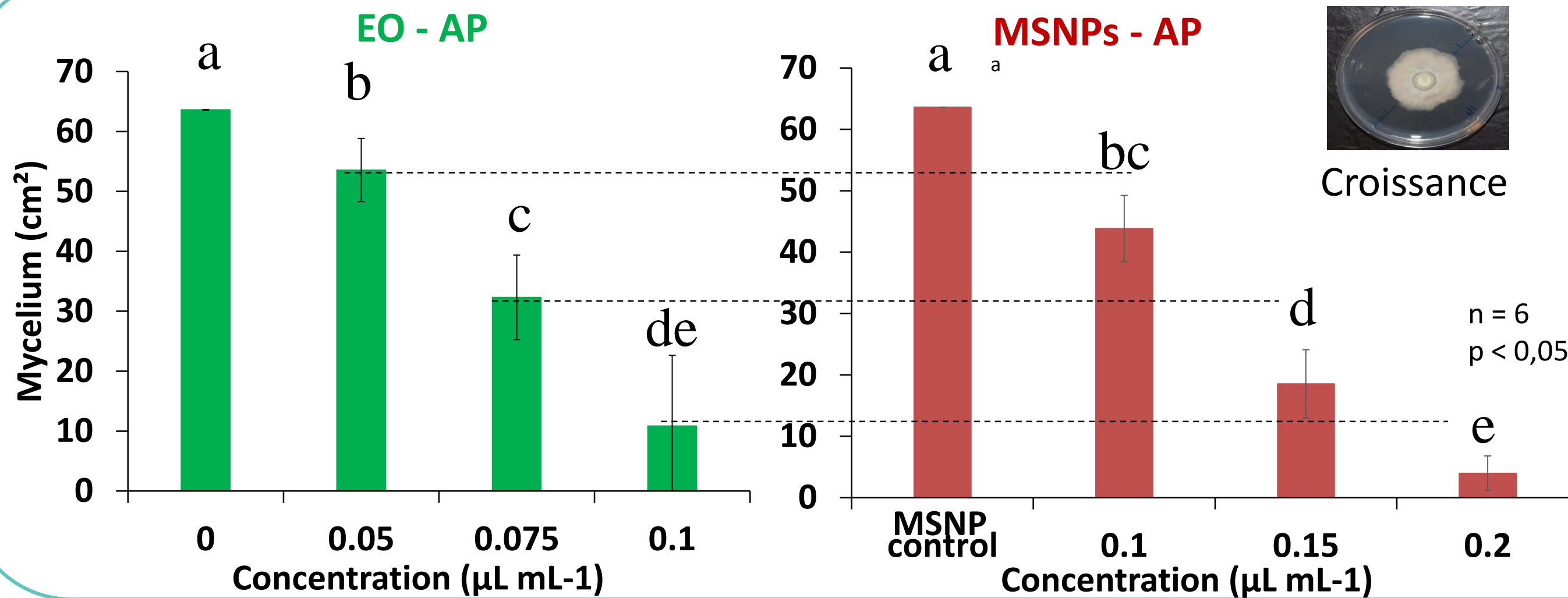
Confirmation of Eos' encapsulation
encapsulation yield for AP = 42 %
encapsulation yield for TC = 69 %



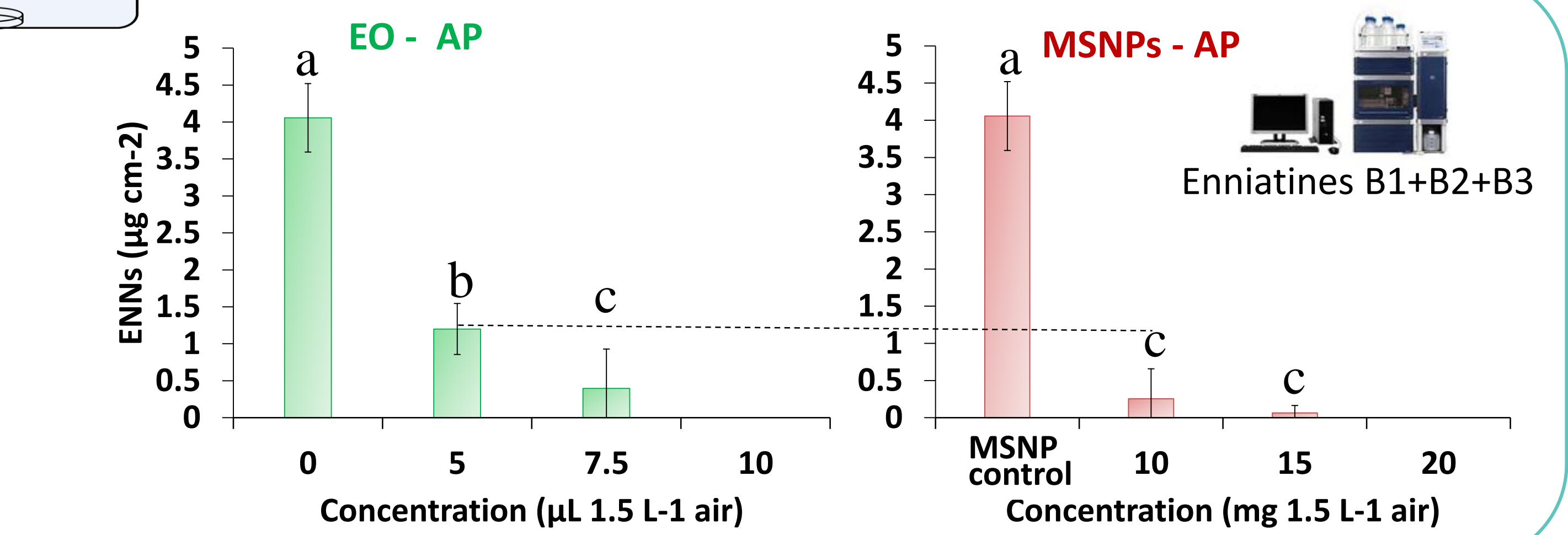
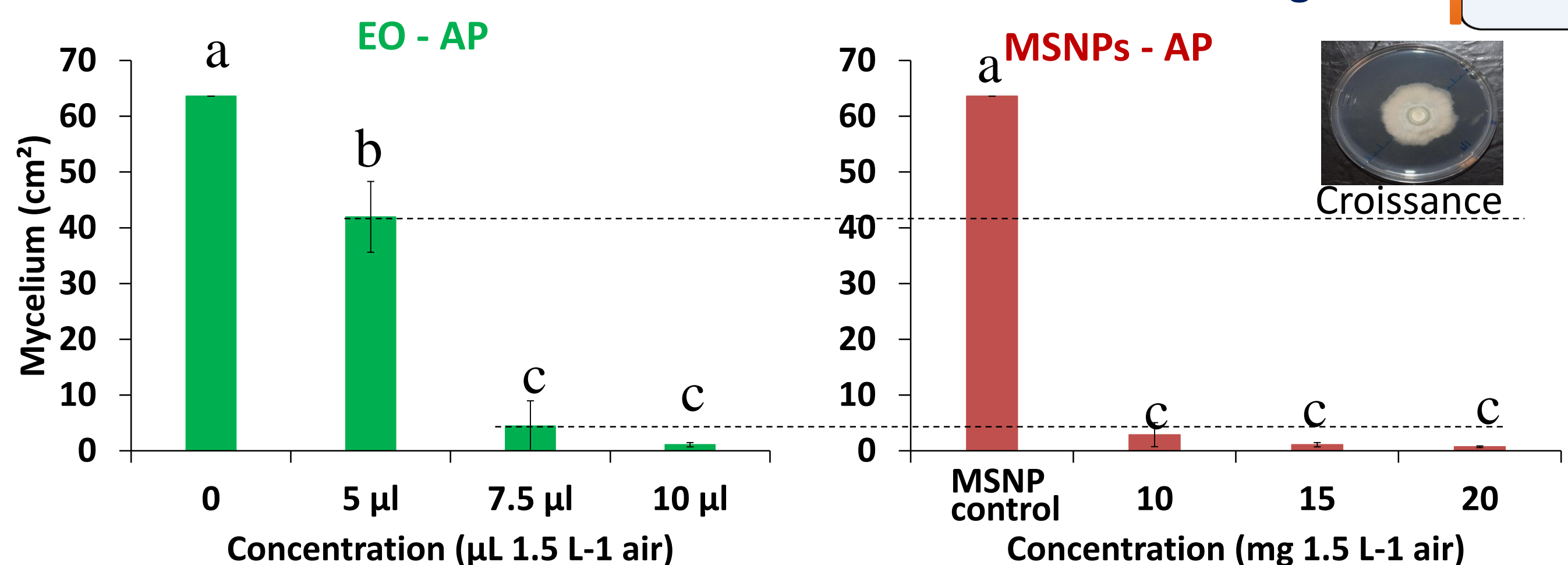
Increased diffusion time of EO after encapsulation in MSNPs

Antifungal and antimycotoxin activities

Contact



Fumigation



MSNPs (without) in contact inhibited significantly the accumulation of enniatins by *Fusarium avenaceum*

Encapsulation in MSNPs improved the antifungal and anti-enniatiens activity of *Ammoides pusila* on *Fusarium avenaceum*