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Encapsulation strategies for studying soil bacterial interactions

Nina Nováková[1], Jan Jansa[2], Ondřej Kašpar[1], Viola Tokárová[1]

[1]Department of Chemical Engineering, University of Chemistry and Technology Prague, Technická 3, 166 28 Prague 6, Czech Republic
[2]Institute of Microbiology of the Czech Academy of Sciences, Vídeňská 1083, 142 00 Prague 4 - Krč, Czech Republic

e-mail: Nina.Novakova@vscht.cz

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Microbial interactions in soil, including those mediated by quorum sensing, are strongly influenced by spatial organization and cell-to-cell communication. However, investigating these processes under controlled conditions remains challenging, particularly in systems involving bacteria–fungi interactions. This work addresses this limitation by employing microbial encapsulation as a strategy for controlled spatial organization of soil bacteria using alginate beads. Model Gram-negative and Gram-positive soil bacteria were immobilized in alginate matrices, with the addition of polyvinyl alcohol (PVA) to tune mechanical stability and bacterial release kinetics, while chitosan was applied as a surface coating to further modulate matrix permeability. Encapsulation performance was assessed by determining viable cell counts (CFU) within the encapsulated matrix and quantifying bacterial release from the beads over time. The influence of formulation parameters, including PVA content and chitosan coating, on bacterial retention and stability was systematically evaluated. Preliminary results show that viable cell populations are maintained within alginate beads, while increasing PVA content reduces bacterial release. Initial experiments with chitosan-coated beads indicate further potential for limiting release through surface modification of the matrix.

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