Gated Mesoporous Silica Particles for Controlled Release of Essential Oil Components

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Abstract:

Two of the most important features of the active compounds for pharmaceutical, food and agriculture applications are its antimicrobial and antioxidant properties. However, there is a huge need to find new alternatives to current non-natural agents since many of these compounds can have severe side effects. Based on this, in our work we use active natural compounds as an alternative to the synthetic ones used so far. In this context, plants remain one of the most valuable sources of natural bioactive molecules, and among them essential oil components (EOCs) have been known since the Middle Ages for their antiseptic and therapeutic properties and their intense aroma. The properties of EOCs have aroused great interest in sectors such as pharmaceutical, food and agriculture as their use allows the reduction of synthetic chemicals, thus protecting the ecological balance. EOCs have shown antibacterial, antifungal, antiparasitic, insecticidal, antioxidant and anti-inflammatory properties. However, EOCs are volatile liquids, soluble in organic solvents and generally with lower solubility in water and, it is precisely their high volatility and water insolubility that makes their use very complicated. Faced with this problem, we propose here the encapsulation and controlled release of EOCs as an interesting alternative to reduce their volatility, as well as to prevent their decomposition before reaching the target point, thereby increasing the effectiveness and efficacy of their action. In this scenario, antimicrobial studies against different microorganisms have been carried out for capped-mesoporous silica materials loaded with essential oil components (EOCs). These systems are based on the employment of silica mesoporous particles whose surface has been modified by grafting sugar or protein molecules acting as “molecular gates” to encapsulate the EOCs. Then, in the presence of the appropriate stimuli (such as exogenous enzymes from microorganism), the gate is “opened” and the EOCs are allowed to be released. It has been demonstrated that the attachment of a sugar or protein derivatives on the surface of mesoporous silica nanoparticles (MSNs) supports provides a suitable method for the design of mesoporous systems that are able to deliver essential oil components by a bio-controlled uncapping mechanism using exogenous enzymes from microorganisms, hence improving their antifungal or antibacterial activity.