



Il Contributo dei Giovani Chimici in Campania

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Anti-solvent driven lignin particles production, characterization and active ingredients loading

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The growing global population has increased the demand for food, intensifying agricultural practices. The widespread use of fertilizers and pesticides, while necessary for crop yields, leads to significant environmental issues such as soil contamination and water pollution [1]. Engineered nano- or micromaterials offer a promising solution by enabling the development of smart carriers designed to deliver active ingredients (AIs) in a controlled manner. These carriers can release AIs upon exposure to factors like light, pH, temperature, or enzymes [2], minimizing environmental impact by reducing leaching and runoff.

Lignin, a natural surfactant, provides a unique platform for these smart carriers. Its amphiphilic properties, derived from its polyphenolic structure, enable the self-assembly of lignin-based materials for controlled release [3]. This study investigates the use of agricultural food waste to create lignin-based nano- and microcarriers for fertilizers and pesticides, supporting sustainability and circular economy principles. A novel aspect of this work is the use of levulinic acid, derived from cellulose catalytic hydrolysis [4], as a green solubilizing agent, replacing traditional solvents like tetrahydrofuran and acetone.

Lignin's self-assembly capabilities [5] allow for the encapsulation of hydrophobic AIs via an anti-solvent process, providing a sustainable method for agrochemical delivery. This research contributes to the advancement of functional soft matter systems and bio-based materials, developing efficient, eco-friendly, and responsive agrochemical delivery systems. The use of lignin-based nano- and microcarriers offers significant potential to reduce pollution, improve crop yields, and promote sustainable farming practices

Keywords: Lignin; levulinic acid; smart carriers; pesticides; sustainable agriculture.

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