

From olive waste to bioactive colloids: valorization of maslinic acid through solid lipid nanoparticles

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The olive oil industry generates vast quantities of by-products that represent an untapped reservoir of high-value compounds. Maslinic acid (MA), a pentacyclic triterpene abundant in these residues, possesses significant antioxidant, anti-inflammatory, and antitumoral properties. However, the successful translation of its bioactive profile into practical applications is hindered by its low aqueous solubility (3.6 µg/L) and consequent poor bioavailability. To overcome these physicochemical limitations and revalorize this agro-industrial waste, this work aimed to engineer MA-based Solid Lipid Nanoparticles (MA-SLNs) as a sustainable and highly stable nanopatform designed for the future delivery of hydrophobic drugs for cancer treatment. We synthesized MA-SLNs via a solvent-displacement method, and physicochemical properties, including the organic-to-aqueous phase ratio and surfactant concentration, were optimized to yield highly monodisperse nanoparticles of approximately 130 nm with a strong negative surface charge (-35 mV). To prove the capacity of this system as a versatile co-delivery platform, curcumin was encapsulated as a model highly hydrophobic molecule, demonstrating enhanced encapsulation efficiency, structural integrity, and sustained retention over time. Furthermore, the biological performance of the engineered nanocarriers was evaluated in tumoral cell lines to validate their capability to internalize and act as future vehicles for complex therapies. Confocal laser scanning microscopy revealed rapid and efficient cellular internalization of the MA-SLNs in these *in vitro* models, successfully overcoming the biological transport barriers associated with the free compound. Additionally, *in vivo* biodistribution studies in murine models demonstrated a highly favorable physiological profile. The nanocarriers maintained their physical stability in systemic circulation and showed safe accumulation patterns in highly irrigated organs, with no signs of acute toxicity or macroscopic tissue alterations. These comprehensive results highlight the potential of this nanotechnological approach to transform olive oil milling waste into advanced, bioavailable colloidal systems for pharmacological applications.

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