

Formulation of *Psidium guajava* Linn essential oil encapsulated solid lipid nanoparticles and evaluation of its anti-inflammatory and antioxidant activity

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Essential oils (EOs) possess significant therapeutic properties but are limited by volatility, instability, and poor bioavailability. This study aimed to encapsulate *Psidium guajava* Linn EO within solid lipid nanoparticles (SLNPs) to enhance its stability and biological efficacy. The objectives were to extract EO from *P. guajava* leaves through hydrodistillation, encapsulate EO into SLNPs, characterize the nanoparticles, and evaluate their antioxidant and anti-inflammatory activities. SLNPs were prepared using high-shear homogenization followed by ultrasonication, utilizing cocoa butter (1.8 g) as the lipid matrix, lecithin (1.2 g) as the emulsifier, and distilled water (196 ml) as the aqueous phase. The EO-loaded SLNPs exhibited a particle size range of 139.7–145.9 nm with a polydispersity index below 0.3, indicating uniform size distribution. A highly negative zeta potential (-46.8 to -48.2 mV) confirmed good colloidal stability, reducing aggregation risks. Fourier-transform infrared spectroscopy (FTIR) confirmed successful encapsulation without chemical degradation, while scanning electron microscopy (SEM) revealed smooth, spherical to slightly elongated nanoparticles. Encapsulation efficiency was 77.94%, with a loading capacity of 20.65%, ensuring effective entrapment of EO

within the lipid matrix. Antioxidant activity, assessed via the DPPH assay, showed that free EO had an IC_{50} of 42.68 ± 2.01 mg/mL, whereas encapsulated EO had a slightly higher IC_{50} of 56.81 ± 2.14 mg/mL, indicating a controlled-release effect. Despite a minor reduction in radical scavenging activity, encapsulation significantly improved EO stability, reducing susceptibility to oxidation. Anti-inflammatory activity, evaluated using the egg albumin denaturation assay, demonstrated that EO-loaded SLNPs exhibited a higher inhibition ($47.73 \pm 1.44\%$) than free EO ($42.28 \pm 3.40\%$), suggesting enhanced bioavailability and prolonged therapeutic effects. Overall, nanoencapsulation improved the stability, controlled release, and therapeutic potential of *P. guajava* EO, making SLNPs a promising delivery system for pharmaceutical applications. Future studies should optimize formulation parameters and conduct *in vivo* studies for clinical validation.

Keywords:

essential oil, solid lipid nanoparticles, nanoencapsulation, antioxidant activity, anti-inflammatory activity.