Supplementary Material:

Detailed Methods for Viscosity and Conductivity Measurements

Viscosity Measurement

The viscosity of chitosan formulations listed in Table 2 was measured using a Ubbelohde capillary viscometer at 25°C. Prior to measurement, samples were filtered through a 0.45 μm membrane to remove undissolved particles. For each sample, 10 mL of solution was introduced into the viscometer, and flow time was recorded in triplicate to ensure accuracy. The relative viscosity (η_r) was calculated as the ratio of the flow time of the chitosan solution (t_i) to that of the pure solvent (90% acetic acid, t_0):

$\eta_r = t_i / t_0$

Specific viscosity (η_{sp}) was calculated as $\eta_r - 1$, and reduced viscosity (η_{red}) was calculated by dividing η_{sp} by the polymer concentration. Intrinsic viscosity $[\eta]$ was obtained by extrapolating the reduced viscosity to zero concentration using linear regression. All measurements were performed in triplicate and averaged. These viscosity parameters provide insights into the rheological properties influencing nanoparticle formation during electrospraying.

Conductivity Measurement

Conductivity of each chitosan formulation was measured at 25°C using a calibrated digital conductivity meter. Samples were equilibrated to room temperature and gently homogenized prior to measurement. The conductivity electrode was rinsed with deionized water and dried between measurements to prevent cross-contamination. Each sample was measured in triplicate, and the average conductivity values (μS/cm) were recorded.

SEM and DLS data for non-optimized formulations

SEM and DLS data for non-optimized formulations (e.g., F_1 and F_8) are presented as sample data in the supplementary material, while the optimized formulations are detailed in the main manuscript.

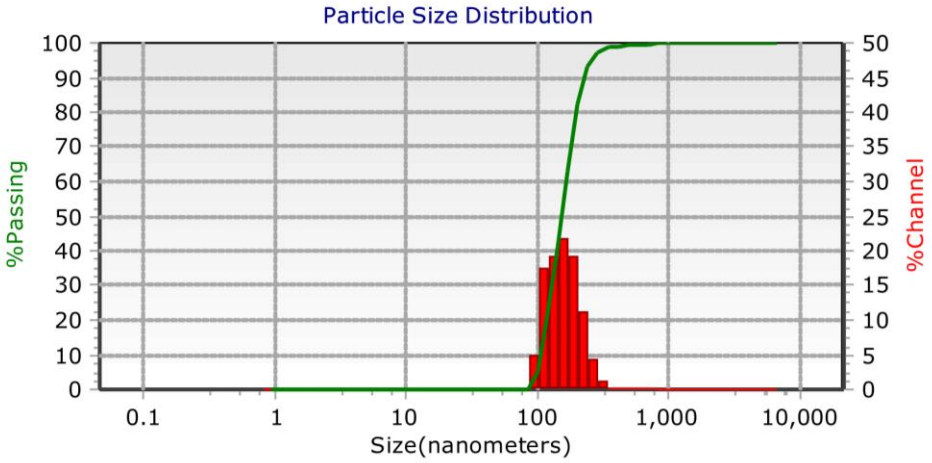

Fig 1. DLS of F_1 formulation

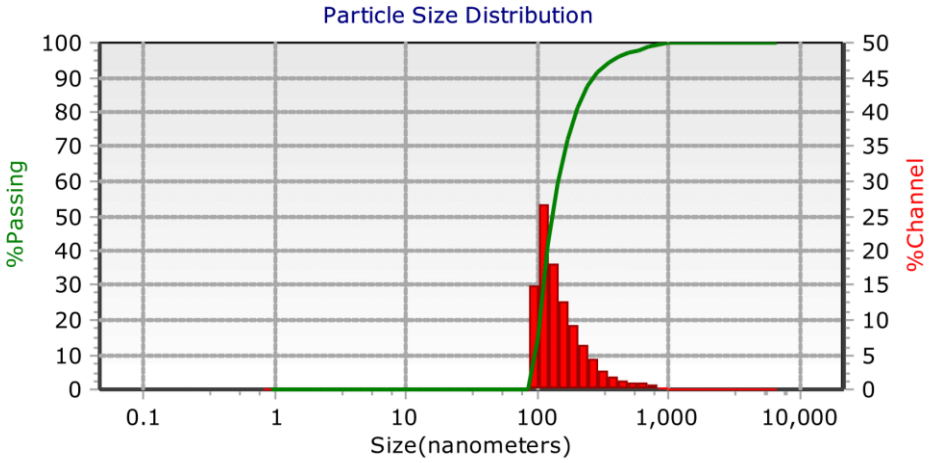

Fig 2. DLS of F_8 formulation

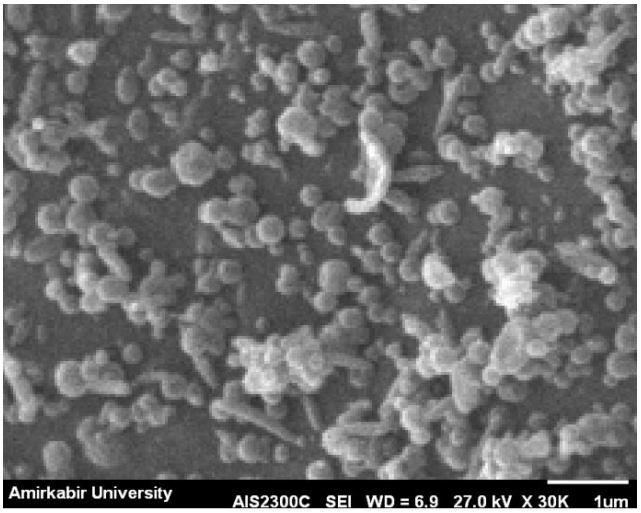

Fig 3. SEM of F_1 formulation

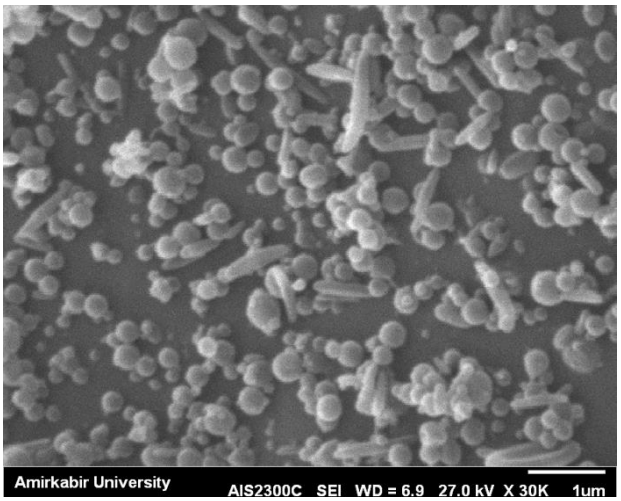

Fig 4. SEM of F_8 formulation