Spray freeze drying for dry powder inhalation of nanoparticles

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Abstract:

Formulating nanoparticles for delivery to the deep lung is complex and many techniques fail in terms of nanoparticle stability. Spray freeze drying (SFD) is suggested here for the production of inhalable nanocomposite microcarriers (NCM). Different nanostructures were prepared and characterized including polymeric and lipid nanoparticles. Nanoparticle suspensions were co-sprayed with a suitable cryoprotectant into a cooled, stainless steel spray tower, followed by freeze drying to form a dry powder while equivalent compositions were spray dried (SD) as controls. SFD-NCM possess larger specific surface areas (67–77 m²/g) and lower densities (0.02 g/cm³) than their corresponding SD-NCM. With the exception of NCM of lipid based nanocarriers, SFD produced NCM with a mass median aerodynamic diameter (MMAD) of 3.0 ± 0.5 μm and fine particle fraction (FPF ≤ 5.2 μm) of 45 ± 1.6% with aerodynamic performances similar to SD-NCM. However, SFD was superior to SD in terms of maintaining the particle size of all the investigated polymeric and lipid nanocarriers following reconstitution (Si/Si ratio for SFD ≤ 1 versus >1.5 for SD). The SFD into cooled air proved to be an efficient technique to prepare NCM for pulmonary delivery while maintaining the stability of the nanoparticles.

Keywords:

Spray freeze drying; Spray drying; Pulmonary; Nanoparticles; Dry powder; Inhalation; Nanocomposite microcarriers

Published In:

European Journal of Pharmaceutics and Biopharmaceutics, 87 (3), 510-517