NANOPARTICLES OF PLA/PLGA BIOPOLYMERS PREPARED BY NANO SPRAY DRYING

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Abstract

Biopolymers based on lactic acid and glycolic acid have attracted great interest in various medical applications. This paper reviews various applications of nano spray drying for the formulation and encapsulation of active ingredients in PLA/PLGA biopolymers. The researched applications are primarily in the therapeutic field, such as the treatment of inhalation diseases, inflammations, cancer, immune diseases, genetic disorders, and the regulation of vasodilatation or the surface coating of medical implants.

Keywords: nano spray drying, nanoparticles, encapsulation, drug delivery, PLA, PLGA

1. Introduction

Biopolymers based on lactic acid and glycolic acid have attracted great interest as drug carrier substances for the production of drug delivery systems with excellent biocompatibility, adjustable degradation rate and non-toxicity in humans (Sharma et al. 2016). This paper reviews the potential of nano spray drying poly(lactic-co-glycolic acid) (PLGA) and polyactic acid (PLA) biopolymers and presents the latest applications for the nanoencapsulation of various drugs (Arpagaus, 2019).

2. Material and method

Fig. 1 shows the set-up of the Nano Spray Dryer B-90 (Arpagaus et al., 2009) in a closed mode operation with the Inert Loop B-295 for drying organic solvents. The system comprises a vibrating mesh nebulizer, a laminar drying process and an electrostatic particle collector, which enable the production of a few grams of submicron powder for feasibility studies.

Fig. 1. Nano Spray Dryer B-90 with the Inert Loop B-295 for closed mode operation with inert gas (N_2/CO_2) for drying organic solvents, adapted from Büchi Labortechnik AG (2017).
3. Results and discussion

The key parameters controlling the final nano spray dried particle size are the vibrating spray mesh size (e.g. 4.0, 5.5, and 7.0 µm mesh size), the solid concentration, and the physicochemical properties of the fluid, such as viscosity and surface tension (Arpagaus et al. 2018, 2017). The main organic solvents used in the nano spray drying of PLA/PLGA biopolymers are: dichloromethane (DCM) (Beck-Broichsitter et al. 2012; Bege et al. 2013; Dahili et al. 2017; Dahili and Feczkó, 2015; Draheim et al. 2015; Panda et al. 2016; Schafroth et al. 2012), acetone (Beck-Broichsitter et al., 2015; Draheim et al., 2015), acetonitrile (Amsalem et al., 2017), ethyl acetate (Draheim et al., 2015), and mixtures of DCM/ethanol (70/30, v/v) (Schafroth et al., 2012). The latest research activities in nano spray drying of PLA/PLGA biopolymers focus on the treatment of:

- inflammation by dexamethasone (Schafroth et al., 2012),
- transplants rejection reactions and dermatitis by cyclosporine (Schafroth et al., 2012),
- pulmonary arterial hypertension with sildenafil (Beck-Broichsitter et al., 2012, 2015),
- antipsychotic diseases by clozapine and risperidone (Panda et al., 2016),
- breast cancer by simvastatin (Anzar et al., 2018),
- genetic disorders and silencing of transcription during gene expression by siRNA-loaded human serum albumin nanoparticles (Amsalem et al., 2017), and
- cerebral vasospasm (e.g. narrowing of blood vessels) by nimodipine (Bege et al., 2013).

4. Conclusions

The analysed studies show the potential of producing nano spray dried PLA/PLGA particle systems from approx. 2 µm to below 200 nm and encapsulation of various active ingredients in spherical particles and nanocomposite structures.

5. References


