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RESEARCH ARTICLE

Modeling the Parameters Involved in Preparation of PLA Nanoparticles Carrying Hydrophobic Drug Molecules Using Artificial Neural Networks

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Abstract
Purpose Artificial neural networks (ANNs) are used to optimize a formulation of poly(lactic acid) (PLA) nanoparticles containing hydrophobic drug molecules through a study of the critical parameters affecting nanoparticle size.
Methods We evaluate the effect of input variables, including concentrations of PLA and Tween 80, amplitude of ultrasound wave, and sonication time on the formation of PLA nanoparticles, which were prepared using a solvent evaporation method. Budesonide was used as a model hydrophobic drug. An ANN model was created using training data and evaluated for prediction capability using validation data.
Results The ANN model demonstrated that reducing PLA concentration and increasing Tween 80 concentration provided optimum conditions for the preparation of small particle size. Additionally, the simultaneous use of high sonication time and amplitude has an adverse effect on particle diameter.
Conclusion By defining the effects of each parameter on the size of PLA nanoparticles, this study demonstrated the feasibility of using an ANN model to optimize the conditions for achieving minimum particle size in hydrophobic drug-loaded PLA nanoparticles.

Keywords Artificial neural networks · PLA nanoparticle · Particle size · Budesonide · Solvent evaporation method

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Introduction

Poly(lactic acid) (PLA), a biodegradable aliphatic polyester, has been widely used in drug delivery systems due to its good biocompatibility and physical properties, such as high mechanical strength and thermoplasticity [1–4]. During the last two decades, based on a number of distinct advantages of submicron-sized particles, a great deal of research has been focused on the development of methods for the preparation of PLA nanoparticles. Some of the techniques employed include nano-precipitation, interfacial deposition, salting out, and solvent evaporation. The solvent evaporation method has gained particular attention because it is a straightforward approach to prepare small and relatively mono-dispersed nanoparticles. This method is based on the creation of nanodroplets from organic solvent containing drug and polymer (e.g., PLA), using a dispersing agent and high-energy homogenization [5].