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ORIGINAL PAPER

Production of polycaprolactone–polyethylene glycol–sodium alginate biocomposites for spray drying encapsulation of L-ascorbic acid

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Abstract L-Ascorbic acid was encapsulated in biopolymers to enhance (1) its encapsulation efficiency and (2) drug release ratio using different pH media. To achieve this goal, we used polycaprolactone (PCL), polyethylene glycol (PEG), and sodium alginate (SA) to prepare drug delivery system and spray dryer as our tool to obtain microspheres. In this manner, the importance of the study was to produce a stable and effective drug encapsulation system by PCL–PEG–SA polymer mixture by spray dryer. First we evaluated the effects of drying conditions and composition on the microencapsulation formulation and in the next stage the most uniformly distributed particles were selected and L-ascorbic acid was loaded. After that, drug encapsulation and drug release studies were performed. Drug release experiments were conducted at different pH solutions (pH 2.5, 7.4, and 9.6). Finally, drug release kinetics was determined by widely used equations to describe the degradation kinetics; zero-order, first-order, Higuchi, Hixson–Crowell, and Korsmeyer–Peppas. Furthermore, L-ascorbic acid release mechanism from microspheres was also determined. The release profiles of three microspheres obeyed the earlier developed kinetic models for performing possible release mechanisms. The Korsmeyer–Peppas model best described each release scenario.

Keywords Drug encapsulation · L-Ascorbic acid · Polycaprolactone · Polyethylene glycol · Sodium alginate · Spray drying

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Introduction

The basic principles for the development of drug delivery systems are comprised of easy integration of active ingredient into drug, achieving higher drug release ratios, and non-toxic effects of drug capsule on the cells after its biodegradation. In the last 10 years, production of more effective, biocompatible and biodegradable drug systems have increasingly attracted the attention of pharmaceutical industry [1–3]. Nowadays, polyester-based biopolymers are used for drug delivery and encapsulation systems and some examples of these polymers are PCL, PEG, PLA, PGA, SA, polyacrylic acid (PAA), poly(methyl methacrylate) (PMMA), chitosan, chitin, and starch [4–6].

Another important issue for drug delivery systems is their shelf stability and sufficient degradation of drugs inside human body. To overcome this problem, polymeric-based drug delivery systems could be an enormous alternative because biodegradation rate is easily adjustable by polymer blends [7–9]. In this way, stability, effective biodegradation rate, and higher drug release contents for a drug could be achieved simultaneously.

Stability of a drug depends on the protection capacity of active ingredient, thus if a polymer is used for an encapsulation system, it forms temporary stable interaction between the active ingredient to deliver system on targeted cells before releasing.

All these views on preparation of a drug, easily biodegradable, biocompatible inside the body and stable outside it, is the main problem and most important goal for pharmaceutical industry [10–12].

It is always a fact that performance of a drug delivery system is about encapsulation and release efficiency. One of the basic requirements for a controlled and balanced