Handbook of Composites from Renewable Materials

Volume 6
Polymeric Composites

Edited by

Vijay Kumar Thakur, Manju Kumari Thakur and Michael R. Kessler

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Martin Scrivener (martin@scrivenerpublishing.com)
Phillip Carmical (pcarmical@scrivenerpublishing.com)

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Plant Polysaccharides Blended Ionotropically Gelled Alginate Multiple Unit Systems for Sustained Drug Release

Dilipkumar Pal[1*] and Amit Kumar Nayak[2]

[1]*Department of Pharmaceutical Sciences, Guru Ghasidas Vishwavidyalaya, Koni, C.G., India*
[2]*Department of Pharmaceutics, Seemanta Institute of Pharmaceutical Sciences, Odisha, India*

Abstract
Plant polysaccharides are a class of naturally occurring polymers present as storage carbohydrates in plants consisting of glucose monomers in cereals, root vegetables, rhizomes, seeds, fruits, etc. Recently, these plant derived materials have expanded their significance in the drug delivery research because of non-toxicity, biodegradability, ready availability, eco-friendliness and low extraction expenditure. During the past few decades, various plant polysaccharides have already been used to design oral multiple-unit sustained-release drug delivery systems like microparticles, beads, spheroids, etc. Even, these have been employed as polymer-blends with other polymers for the development of oral multiple-unit sustained-release systems with desired properties like drug encapsulation efficiency, swelling behavior, mucoadhesivity, drug release, etc., through ionic-gelation technique. This technique is simple and economical. In addition, ionotropically-gelled systems are non-toxic. The current chapter contends with some helpful discussions on the already reported different multiple-unit systems as sustained drug release carriers composed of various plant polysaccharides and alginate (a water soluble natural anionic polysaccharide produced from the brown algae) prepared through ionotropic-gelation technique. All these ionotropically-gelled multiple-unit systems were found efficient to encapsulate various drugs in higher percentages and also to sustain the drug release over the extended period with minimization of burst release and quick degradation of matrices.

Keywords: Plant polysaccharides, sodium alginate, polymer-blends, ionotropic-gelation, multiple-unit systems, sustained drug release

15.1 Introduction

During the last few decades, a variety of sustained release drug delivery dosage forms for oral administration have been researched. These sustained drug releasing dosage

*Corresponding author: drdilip2003@yahoo.co.in/drdilip71@gmail.com

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forms for oral delivery offer several important advantages over conventional drug delivery (immediate-release) dosage forms such as target-site specificity, minimizing fluctuations within the therapeutic range, minimum chances of dose dumping, decreased dosing frequency, lower risk of side effects, enhanced bioavailability and good patient compliance (Chein, 1990; Mandal *et al.*, 2010). In recent years, drug delivery researchers and scientists have placed a strong importance on the utilization of various types of natural polymers to design and develop various oral drug delivery dosage forms for sustained drug release as various synthetic polymers employed for this purpose are limited due to hazards associated with the organic solvents resulting biocompatibility (Nayak & Pal, 2015a; Pal & Nayak, 2015a; Voicu *et al.*, 2016). Natural polymers are extracted from natural sources. Therefore, these are readily available, inexpensive and eco-friendly (Hasnain *et al.*, 2010; Thakur *et al.*, 2016). In addition, the biodegradability of natural polymeric groups into the physiological metabolites and their easy modifications compose these as prospective biomaterials in various biomedical applications including drug delivery, tissue engineering, etc (Thakur *et al.*, 2013a,b,c,d, 2014a,b; Thakur & Thakur, 2014a,b, 2015; Thakur & Kessler, 2014; Nayak & Pal, 2015a).

Among single-unit and multiple-unit sustained drug release systems, multiple-unit systems have been proven beneficial over the single-unit systems as these are capable of lowering both the intra- and inter-subject variability of the drug absorption with the reduction of the possibility of dose dumping (Elmowafy *et al.*, 2009; Malakar & Nayak, 2012). In addition, various types of multiple-unit systems for sustained drug release have shown the capability to mix up with the gastrointestinal juices as well as distribute over a wider area in the gastrointestinal tract. These lower the chances of the malfunction of some multiple-units, with less chances of localized mucosal damage and more predictable drug releasing kinetics (Nayak & Pal, 2015a; Pal & Nayak, 2015b). Recently, the formulation of various multiple-unit systems like nanoparticles, microparticles, beads, spheroids, etc., using natural polymers through ionotropic-gelation technique for oral sustained drug releasing delivery, has been widely investigated (Desai, 2005; Bhowmik *et al.*, 2006; Babu *et al.*, 2010; Chakraborty *et al.*, 2010; Das *et al.*, 2010; Assifoui *et al.*, 2011; Jana *et al.*, 2015a,b). Though the ionotropically-gelled multiple-unit systems made of single natural ionic polymers have been investigated as sustained drug releasing carrier matrices, blending of one ionic polymer with another ionic or non-ionic polymer is a commonly adopted approach in the development of multiple-unit sustained drug releasing carrier matrices for oral use (Ahuja *et al.*, 2010; Das *et al.*, 2014; Nayak *et al.*, 2014c,d,e). This also improves some desired functional properties such as enhanced drug encapsulation, controlled swellability, required stability and more sustained drug release (Ahuja *et al.*, 2010; Nayak *et al.*, 2013a). In addition, blending with mucoadhesive polymers offers improvement of biomucoadhesion of multiple-unit systems for suitable gastroretention to improve the site-specific drug delivery and bioavailability (Nayak *et al.*, 2013b, 2014a,b; Nayak & Pal, 2013a).

The current chapter deals with the discussions on already reported different multiple-unit systems as sustained drug releasing carrier matrices composed of plant polysaccharides and alginate (a naturally occurring anionic polymer obtained from brown marine algae) prepared through ionotropic-gelation technique.