Handbook of Composites from Renewable Materials

Volume 8
Nanocomposites: Advanced Applications Science and Fundamentals

Edited by

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Natural Starches-Blended Ionotropically Gelled Microparticles/Beads for Sustained Drug Release

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Abstract

Starches are naturally occurring biopolymers with diverse applications in polymer sciences, present as storage carbohydrates consisting of glucose monomers in cereals, root vegetables, rhizomes, tubers, corms, and seeds of plants as microscopic granules possessing typical origin-specific sizes and shapes. In recent years, natural starches are widely investigated in the designing of various pharmaceutical formulations as these are readily available in nature, cost-effective, biodegradable, and biocompatible. Currently, natural starches have been used to design oral multiple-unit sustained release systems like microparticles, beads, etc. The present chapter deals with helpful and comprehensive discussions on the already reported different microparticles/beads as sustained drug release carrier systems composed of various natural starches and ionic polysaccharides prepared through ionotropic gelation technique. All these natural starches-blended ionotropically gelled microparticles/beads systems were found suitable to encapsulate various kinds of drugs and to sustained release of encapsulated drugs over prolonged period.

Keywords: Natural starches, polymer blends, ionotropic gelation, microparticles, beads, sustained drug release

20.1 Introduction

Controlling release of various small molecular drugs from hydrophilic biopolymeric matrices has remained a big challenge in the field of drug delivery research during past few decades. Basically, small molecular drug molecules embedded in the hydrophilic biopolymeric matrices exhibits a faster drug-releasing pattern (Chein, 1990; Longer & Robinson, 1990). Unfortunately, such faster drug-releasing pattern is undesirable to achieve prolonged actions mainly for the drugs with short biological half-lives (Longer & Robinson, 1990). The drugs of short biological half-lives and higher water solubility warrant extensive research as well as technological efforts to minimize dose-associated

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side-effects and to decrease frequent dosing through controlling the drug-releasing rate through the development of sustained drug-releasing dosage forms (Chein, 1990). The oral sustained drug-releasing dosage forms present some important advantages over the conventional immediate-release drug delivery dosage forms like target site specificity, minimizing fluctuations of the systemic drug concentrations within the therapeutic ranges, minimum chances of dose dumping, reduced dosing frequency, lower risk of side-effects, enhanced bioavailability, and excellent patient compliances (Nayak & Pal, 2015a). The drug releasing from hydrophilic biopolymeric systems depends on the characteristics of the chosen matrix systems and the types of the drug-releasing devices employed (Nayak, 2011).

In recent years, extensive research endeavors have been directed towards the formulation development of various types of single-unit as well as multiple-unit systems for the oral sustained drug delivery of low molecular weight drugs. Various multiple-unit systems for the sustained release of drugs present some benefits over the single-unit systems, since these have been revealed to limit the inter- and intrasubject variability in the absorption of drugs and to lesser the chances of dose dumping (Elmowafy *et al.*, 2009; Malakar & Nayak, 2012). Multiple-unit systems are able to mix with the gastrointestinal juice and are distributed over the larger area in the gastrointestinal tract (GIT), which results the absence of impairing performances owing to malfunction of some units, more predictable release of drugs and lesser chances of localized mucosal damages (Nayak & Pal, 2015b; Nayak, 2016). In addition, multiple-unit systems evade the vagaries of gastric-emptying and diverse transit rates by the GIT; in that way, drugs are released from these systems more consistently and avoid the experience to higher drug concentrations as compared to that of single-unit drug delivery systems (Malakar *et al.*, 2012). Even for the delivery of recommended total doses of drugs, these multiple-unit drug delivery systems are filled into sachets or capsules and/or compressed into tablets. In recent years, various multiple-unit systems such as nanoparticles, microparticles, beads, spheroids, etc. made of natural polymers through ionotropic gelation technique are being investigated for oral sustained drug-releasing delivery (Racovita *et al.*, 2009). To develop these multiple-unit drug delivery systems, natural polymers are being preferred as the use of various nature-derived materials in a variety of pharmaceutical applications are increasing significance gradually (Nayak *et al.*, 2010; Pal & Mitra, 2010; Nayak *et al.*, 2012, 2015; Nayak & Pal, 2012; Pal *et al.*, 2012). In addition, natural polymers are inexpensive, biodegradable, nontoxic, and eco-friendly (Hasnain *et al.*, 2010).

Among various natural polymers, polysaccharides are gaining lots of importance concerning biomedical, pharmaceutical, and food application areas as these are also obtainable from various natural renewable resources (Pal *et al.*, 2010; Nayak *et al.*, 2012; Thakur *et al.*, 2016). In fact, polysaccharides possess complex and branched structures composed of several monosaccharide residues connected with each other through the *O*-glycosidic linkages, which exhibit some advantageous functional properties like aqueous solubility or higher swelling ability through easy chemical modifications, stability to pH alterations, etc. (Kaur *et al.*, 2012; Pal & Nayak, 2015). In addition, the biodegradability of natural polysaccharides 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; Pappu *et al.*, 2015).