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International Journal of Pharmaceutics 294 (2005) 113–120
international journal of pharmaceutics
www.elsevier.com/locate/ijpharm

Characteristics of interpolyelectrolyte complexes of Eudragit E 100 with sodium alginate

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Received 10 September 2004; received in revised form 5 January 2005; accepted 17 January 2005

Abstract

With a view to the application in oral drug delivery formulations, the possibility to form interpolyelectrolyte complexes (IPEC) of Eudragit E 100 (EE) with sodium alginate (AL) was investigated, employing turbidimetry, apparent viscosity measurements, FT-IR and elementary analysis. The interaction or binding ratio of a unit molecule of AL with EE was largely affected by the pH value of the media, showing a change from 1.5:1 to 1:1.25 ($0.66 < Z < 1.25$) with increase in pH value from 2.5 to 6.0. Based on the results of elementary analysis and FT-IR, the interaction ratio of each component in the solid complexes was very close to that observed in turbidity and apparent viscosity measurements thus proving that the synthesized products actually can be considered as IPEC.

Keywords: Interpolyelectrolyte complex; Eudragit E 100; Sodium alginate; Solution apparent viscosimetry; Infrared spectroscopy; Turbidimetry; Elementary analysis

1. Introduction

The use of different types of Eudragits for controlled drug delivery has been well known for several years. Since Eudragits can act as polyelectrolytes, they can be used for many purposes such as enteric drug formulation, or swelling controlled drug release regulated by the percentage of charged and non-ionized (ether) groups in the molecular structure of methyl-(ethyl)-methacrylate copolymers. Some of them can be considered as polycations (Eudragit types E, RL, RS, NE) and others as polyanions (Eudragit types L, S). The first ones have positively charged groups: dimethylamino groups in Eudragit type E, or quaternary amino groups in Eudragit types RL, RS and NE. The second ones have

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doi:10.1016/j.ijpharm.2005.01.029

negatively charged groups: carboxyl groups in Eudragit types L and S.

Interpolyelectrolyte complexes (IPEC), obtained as precipitates by mixing cationic and anionic polymers in aqueous solutions, have often been reported. It is known that the stoichiometry of both components in binary IPEC depends on the pH values of the media, ionic strength, concentration and sometimes on the order of mixing (Kabanov, 1972; Fukuda, 1979). Although, the advantages of using IPEC as a polymer carrier in controlled release systems are well known (Kawashima et al., 1985; Lorenzo-Lamoza et al., 1998; Takahashi et al., 1990; Majeti and Kumar, 2000; Takayama et al., 1990; Miyazaki et al., 1994, 1995; Sezer and Akbuğa, 1999a,b; Takka and Acartürk, 1999; Sezer and Akbuğa, 1999b; Mitrevej et al., 2001), the possibility of using Eudragits in IPEC is not well investigated. To the best of our knowledge, the only scientific report dealing with the use of Eudragit in IPEC is that in which ionic interactions of Eudragit S with chitosan are described, although the authors observed only the ionic interaction by IR analysis in a pellet film coating during the release measurements. Unfortunately they did not make a complete investigation of the system (Lorenzo-Lamoza et al., 1998).

The purpose of the present study was to investigate the basic physicochemical properties of IPEC composed of Eudragit type E100 (EE) with sodium alginate (AL). Fig. 1 shows the molecular structures of the polymers. EE was selected as a polycation because of its solubility in acidic conditions. The use of other cationic types of Eudragit is not possible because they are pH independent and not soluble in aqueous solutions. On the other hand, AL was used as the anionic polymer.

2. Materials and methods

2.1. Materials

EE and AL were generously donated by Rohm Pharma (Darmstadt, Germany), and Federa (Brussels, Belgium), respectively. The polymers were used after vacuum drying at 40 °C during 2 days.

2.2. Turbidity measurements

Solutions of EE (0.0001–0.001 M) in acetate buffer (0.05 M; pH 2.5–6.0) were mixed with solutions of AL (0.0001–0.001 M) in acetate buffer (0.05 M; pH 2.5–6.0) at constant temperature. The turbidity of each sample solution was determined at 600 nm (a wavelength where no absorption due to the polymers occurred), using a UVIKON 810P spectrophotometer (Kontron Instruments, Van Hopplynus, Brussels, Belgium).

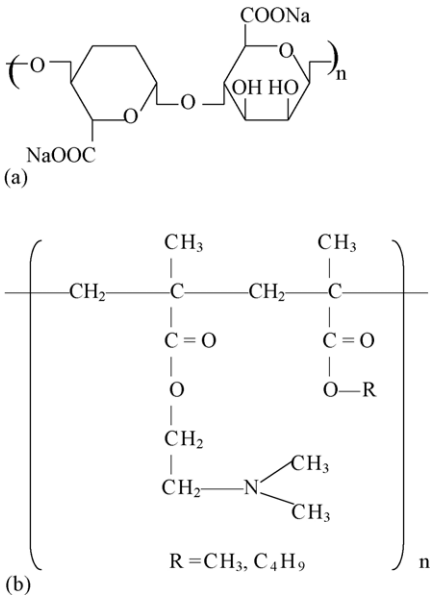

Fig. 1. Molecular structures of alginic acid (a) and Eudragit E 100 (b).

2.3. Apparent viscosity measurements

Solutions of EE (0.0001–0.001 M) in acetate buffer (0.05 M; pH 2.5, 4.0 and 5.5) were mixed for 10 min with solutions of AL (0.0001–0.001 M) in acetate buffer (0.05 M; pH 2.5, 4.0 and 5.5) at constant temperature using the vibromixter Hellma CUV-MIX 342. After centrifugation for 1 h at 5000 rpm with rotor cooling at 5 °C in a MLW K23D centrifuge, the specific viscosity of the supernatant solution was determined at 25.0 ± 0.1 °C using a Ubbelohde viscometer.

2.4. Synthesis of solid IPEC

A solution of EE (0.01 M) in acetate buffer (0.05 M; pH 2.5–6.0) was mixed with a solution of AL (0.01 M) in acetate buffer (0.05 M; pH 2.5–6.0) at constant