Physicochemical characterization of a novel chitosan derivative, chitosan sodium biphthalate

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Abstract

Chitosan sodium biphthalate (CSBP) was developed in order to improve the solubility in higher pH media. It was prepared from chitosan (CS) via ring-opening reactions with phthalic anhydride at the partial N-position group of glucosamine units. Physico-chemical properties was investigated by FTIR spectrophotometry and powder X-ray diffraction (PXRD). In the FTIR spectrum of CSBP, the peak assigned to carbonyl stretching (amide I) of phthaloyl amide groups and an asymmetric and a symmetric carboxylate anion stretching were observed indicating the form of CS as sodium biphthalate salt. The halo pattern of PXRD indicated that the substitution of phthaloyl groups at the amino groups of CS made CSBP become an amorphous solid. The solubility of the salt in various pH media was determined by %transmission of the solution using a UV spectrophotometer. CSBP showed much better solubility at neutral and alkaline pH which makes it be possible in applications for enteric and colonic drug release system in pharmaceutical fields.

Keywords: chitosan sodium biphthalate, phthalic anhydride, biopolymer, solubility, physico-chemical property

Introduction

Chitosan is a cationic natural biopolymer composed of β(1-4)-D-glucosamine units. It is generally prepared from chitin by chemical or enzyme reaction. It has a number of properties, such as biocompatibility, biodegradability, nontoxicity, that make it suitable for use in biomedical and pharmaceutical formulations [1]. However, its applications are restricted since CS is soluble only in acid media (pH<5.5) due to the presence of free amino groups along the polymer chain. The presence of these amino groups allows modification of different CS derivatives [2]. Substitutions of chitosan via ring-opening reactions with various cyclic acid anhydrides are the most attractive technique used to improve chitosan solubility and widen its applications [3]. The aim of this study is to develop a novel chitosan derivative, chitosan sodium biphthalate, by reacting CS with phthalic anhydride at the partial N-position groups of the glucosamine units. Physicochemical properties of the salt were characterized by FTIR spectrophotometry and PXRD. The solubility of the salt in various pH media was also evaluated using a UV spectrophotometer.

Experimental and methods

Materials

Chitosan, average molecular weight of 20 kDa with 87% degree of deacetylation was purchased from Seafresh Chitosan Co., Ltd. (Lab.), Thailand. All other chemicals were of reagent grade.

Preparation of CSBP

Chitosan dissolved in 2.5% v/v acetic acid solution was mixed with phthalic anhydride (Ph) in acetone (molar ratio of CS:Ph at 1:0.5) under stirring at 60 °C for 4 h and then left overnight. Afterwards, the mixture was adjusted to pH 6.0 with 0.5 N NaOH solution and dispersed in acetone. The precipitates was filtered and washed by excess acetone, and dried at 50 °C.

Characterization of CSBP

CSBP was characterized using FTIR spectrophotometer (model Magna-IR system 750, Nicolet Biomedical, Madison, WI, USA) and powder X-ray diffractometer (Diffractometer D8, Bruker AXS, Germany). The solubility of CSBP was evaluated from %transmission of the solution in various pH media. The sample (100 mg) was dissolved in 0.1 N NaOH (10 mL). Following stepwise addition of concentrated HCl, %transmittance of the solution at various pH media was measured at 600 nm using a UV spectrophotometer [4].

Results and discussion

Fig.1 showed the FTIR spectra of CS and CSBP. The characteristic peaks of CS at 1652 and 1600 cm⁻¹ assigned to C=O stretching (amide I) and –NH₂ bending, respectively, were observed. In the spectrum of CSBP, the absorption bands of stretching vibration of –OH and –NH at 3500-3400 cm⁻¹ became narrower and shifted to lower wave number after introducing phthaloyl groups. The
carbonyl stretching (amide I) peak near 1644 cm\(^{-1}\) assigned to phthaloyl amide groups was observed while the peak of NH-bending at 1600 cm\(^{-1}\) disappeared. It is suggested that the amino groups of chitosan were substituted with phthaloyl groups. In addition, the strong peak at 1559 cm\(^{-1}\) and 1383 cm\(^{-1}\) regions attributed to an asymmetric and a symmetric carboxylate anion stretching (\(-\text{COO}^-\)) respectively, indicated the form of biphthalate of sodium salt.

In Fig. 2, the crystalline peaks at around 11° and 20° (2θ) were observed in the PXRD pattern of CS. A lot of strong intermolecular and intramolecular hydrogen bonds (H-bonds) make CS form crystalline regions easily and resulted in being insoluble in water. After modification, a halo diffraction pattern of CSBP was observed. It was suggested that the substitution of phthaloyl groups at the amino groups of CS made CSBP become an amorphous solid.

![Fig. 1. FTIR spectra of CS and CSBP](image)

**Conclusion**

CSBP was successfully prepared. Both FTIR spectra and PXRD patterns confirmed the change of chitosan structure to be a sodium biphthalate salt in an amorphous form. CSBP showed much better solubility in neutral and alkaline solution which makes it be possible in applications for enteric and colonic drug release system in pharmaceutical fields.

**References**


The Sixth Thailand Materials Science and Technology Conference

In conjunction with
The Sixth National Chitin - Chitosan Conference
Thailand Textile Symposium 2010

August 26-27, 2010
Miracle Grand Convention Hotel, Bangkok, Thailand

Organized by

Conference Sponsors

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