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ORIGINAL RESEARCH

Preparation of proanthocyanidin–chitosan complex and its antioxidant and antibacterial properties

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Abstract

Chitosan (CS) is a natural polysaccharide with beneficial effects on human health. To further strengthen its biological properties, a CS-based complex was prepared by combining it with proanthocyanidin (PA) and named it as PA–CS in this study. The successful preparation of PA–CS was confirmed by Fourier transform infrared spectroscopy. The size of PA–CS particles was distributed between 10 and 100 μm with a mean value of 30.6 μm and low pH and high salt concentration could increase their swelling ratio. The loading capacity of PA in PA–CS particles was 82.2 ± 1.7 mg/g, and an increased release of PA from the complex occurred at low pH and high salt concentration. After combination, PA–CS complex exhibited better antioxidant activity than CS, which is a result of the synergistic effects of PA and CS. The reducing power and 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity of PA–CS complex are mainly attributed to PA, whereas the superoxide radical scavenging activity of PA–CS complex largely depends on CS. Moreover, PA–CS complex showed similar diameters of inhibitory zone and identical minimal inhibitory concentrations compared with CS, suggesting that the antibacterial potential of PA–CS complex is similar to that of CS. In addition, after 20 days storage, PA–CS complex did not exhibit significant changes in DPPH radical scavenging activity and antibacterial activity, indicating the good stability of this complex.

Keywords Chitosan · Proanthocyanidin · Complex · Antioxidant activity · Antibacterial activity

Introduction

Chitosan (CS), a unique natural cationic polysaccharide, is a partially deacetylated derivative of chitin, the second most abundant biopolymer in the world [1, 2]. CS possesses numerous favorable properties such as biodegradability, biocompatibility, and antimicrobial activities [3]. Therefore, it is extensively applied in various fields including food, biopharmaceutical, and nutraceutical industries [4, 5].

In recent years, the antioxidant activity of CS has also been studied in many systems [6]. However, CS has some limitations in using as a practical antioxidant due to its poor H-atom donating ability [7]. Chemical modification is an effective method to offset this limitation, but it is not suitable for the application in food and biopharmaceutical fields due to the introduction of hazardous chemicals by chemical reactions.

Recently, some studies showed that this limitation can be solved easily by combining CS with natural antioxidants [8]. Especially, the resultants exhibit synergistic effects of CS and the antioxidants, leading to an enhancement in biological properties including antioxidant and antibacterial activities. For example, CS and epigallocatechin gallate conjugate exhibits better emulsifying and antioxidant activity than CS [9]; combining CS with green tea extract enhances the antioxidant and antibacterial properties [10]. More interestingly, the absorption and bioavailability of tea polyphenols are enhanced by combining with CS [11]. Therefore, complexes based on CS and natural antioxidants have become a hot research subject in biomaterials with favorable biological properties and promising applications [12].

Polyphenols, the secondary metabolites of plants, have powerful antioxidant properties as well as nutritious value and beneficial effects on human health [13]. Thus, polyphenols are frequently served as antioxidants to prepare complexes with CS [12]. Proanthocyanidin (PA), a kind of

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