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INCORPORATION OF α-TOCOPHEROL INTO CHITOSAN FILMS: EFFECTS ON FILM PROPERTIES

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KEYWORDS

Edible film, chitosan, α-tocopherol

ABSTRACT

Synthetic packaging films have led to serious ecological problems due to their non-biodegradability, being biopolymers an alternative source for packaging development. Polysaccharides have been exploited as a material for the development of edible films, and additionally can be used as carrier of functional compounds. The aim of this work was to evaluate the effects of the incorporation of α-tocopherol in chitosan based films.

INTRODUCTION

Edible films can act as barrier to the external elements such as water vapour, oxygen providing protection for food products, and at the same time reducing e.g. bruising and breakage and thus improving food integrity. Recently, edible films and coatings appear as efficient vehicle for functional ingredients such as antioxidants in order to enhance food stability, quality, functionality and safety, control the oxidation of fatty components and pigments, contributing to the quality preservation of food (Lin and Zhao, 2007; Sánchez-González *et al.*, 2009). Chitosan, a natural polymer, has several advantages such as biocompatibility, biodegradability and no toxicity (Dutta *et al.*, 2009). The incorporation of antioxidant compounds in chitosan based films can enhance their functional properties improving their potential for commercial food packaging applications (Lee, 2005). α-tocopherol is a natural antioxidant that could help preserving food quality by protecting it from oxidative degradation.

In order to understand the effect of α-tocopherol on chitosan based films the transport, mechanical and thermal properties, and their antioxidant capacity was evaluated.

METHODS

Solubility. The film solubility in water was determined according to the method reported by Casariego *et al.* 2009.

Moisture content. To determine the moisture content of films about 50 mg of film were dried at 105 °C during 24 h. The weight loss of the sample was determined, and the moisture content was calculated as the percentage of water removed from system.

Water vapour transmission rate (WVTR*) and water vapour permeability measurement (*WVP*).* The measurement of WVTR and WVP was performed gravimetrically based on ASTM E96-92 method (Guillard *et al.*, 2003; McHugh *et al.*, 1993).

*Tensile strength (*TS*) and elongation-at-break (*E*).* Mechanical properties were measured with an Instron Universal Testing Machine (Model 4500, Instron Corporation) following the guidelines of ASTM Standard Method D 882-91.

Fourier-transform infrared (FTIR) spectroscopy. The IR spectra of the films were determined using FTIR (Perkin-Elmer 16 PC spectrometer, Boston, USA), in the 400-4000 cm^{-1} zone, using 16 scans, at a resolution of 4 cm^{-1}.

DPPH radical scavenging assay. The scavenging activity was measured using the stable radical 2,2-Diphenyl-1-picrylhydrazyl (DPPH) according to Byun *et al.* (2010).

Thermal analysis. The thermal stability and degradation profile of all chitosan film samples was assessed by thermogravimetric analysis (TGA) with a Shimadzu TGA 50 according to Casariego *et al.* (2009). Samples were heated at a constant rate of 10 $°C.min^{-1}$ from 20 to 580 ºC.

RESULTS & CONCLUSIONS

The increase of α-tocopherol concentrations leads to a decrease of the solubility and moisture content values.

However, only for moisture content and when the α-tocopherol concentration increases from 0 % to 0.2 % exists a statistically significant difference ($p<0.05$) between samples. The presence of α-tocopherol leads to a slight decrease of WVTR values, however the WVP values increase for higher α-tocopherol concentrations. The increase of α-tocopherol concentration results in an increase of the values of thickness, which influence the water resistance trough the film but also can affect the hydrophilic-hydrophobic behaviour of the chitosan based film.

The increase of α-tocopherol concentration leads to a decrease of the *TS* and *E* values of chitosan films. The α-tocopherol presence leads to a less rigid film structure, being the structural discontinuities provoked by the α-tocopherol incorporation responsible by the decreasing of their flexibility and their resistance to fracture (Sánchez-González *et al.*, 2009).

The DPPH radical scavenging activity was 10.69 %/100 mg of chitosan film, whereas the inhibition obtained for 0.1 and 0.2 % of α-tocopherol films was 97.42 and 97.71 %/100 mg of film, respectively.

FTIR spectra of chitosan films with α-tocopherol show the presence of new peaks near to the 3000 cm^{-1} that is associated with the symmetric and asymmetric stretching vibration of $-CH_2$ and $-CH_3$. Also in broad band between 1500-1200 cm^{-1} the presence of new peaks suggest the presence of peaks related with the methyl ($-CH_3$) symmetric bending.

Thermal analysis of chitosan based films presents at least three thermal events, however for samples with α-tocopherol a fourth event exists. The peak 4 (around 440 ºC) only appears in chitosan based films with α-tocopherol, for films with higher α-tocopherol concentrations exist an increase of the weight loss associated with the peak 4. This peak can be related with the aromatic structures present in α-tocopherol with decomposition temperatures above 380 °C (Pelissari *et al.,* 2009).

The results suggested that mechanical, physical and barrier properties of the chitosan films were influenced by the presence of α-tocopherol; and the addition of α-tocopherol to chitosan films leads to an increase of the DPPH radical scavenging activity. Therefore, these films are promising as a mean to improve the final quality and shelf-life of food products.

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