Functional properties of films based on soy protein isolate and gelatin processed by compression molding

P. Guerrero a, P.M. Stefan b, R.A. Ruseckaite b, K. de la Caba a,*

a Universidad del País Vasco, Escuela Universitaria Politécnica, Departamento de Ingeniería Química y del Medio Ambiente, Plaza Europa 1, 20018 Donostia-San Sebastián, Spain
b Research Institute of Material Science and Technology (INTEMA), CONICET Engineering Faculty, Mar del Plata University, Juan B. Justo 4302, 7600 Mar del Plata, Buenos Aires, Argentina

A R T I C L E   I N F O

Article history:
Received 28 July 2010
Received in revised form 21 January 2011
Accepted 2 February 2011
Available online 26 February 2011

Keywords:
Soy protein isolate
Gelatin
Processing
Films
Mechanical properties

A B S T R A C T

Soy protein isolate (SPI) based films, blended with gelatin and plasticized with glycerol at pH 10, were prepared by compression molding with the aim to obtain environmentally friendly materials for packaging applications. Different contents and types of gelatin were incorporated into SPI-based mixtures to improve mechanical properties. All films obtained were flexible and transparent. Films with 15% of bovine gelatin showed higher tensile strength and similar elongation at break compared with the ones without gelatin. Moreover, contact angle measurements showed that the addition of gelatin decreased the hidrophilicity of the films, while UV barrier properties were maintained. The effect of gelatin addition has been explained using Fourier transform infrared (FTIR) and the changes observed in the intensity of the bands corresponding to the amide group showed that gelatin interacts with SPI, which was confirmed by the decrease of total soluble matter.

1. Introduction

Considerable interest in biopolymer films has been renewed due to their environmentally friendly nature and their potential use in the food and packaging industries (Krochta and de Mulder Johnston, 1997). Biopolymers from various natural resources such as starch, cellulose, and protein have been considered attractive alternatives for nonbiodegradable petroleum based plastics. Proteins are generally superior to polysaccharides in their ability to form films with greater mechanical and barrier properties (Cuq et al., 1998) and they could be an alternative resource to bioplastics in packaging applications since they are abundant, renewable, environmentally friendly, and biodegradable (Paetau et al., 1994; Swain et al., 2004). However, there are some limitations in applications due to poor mechanical properties and high sensitivity to moisture.

Proteins are very different depending on their origin, structures and amino acid composition. Soy protein is extracted from soybeans used to obtain soy oil. During this process, soy flour is obtained as a secondary product and it can be purified to obtain soy protein concentrate (SPC) and soy protein isolate (SPI), which would add value to agricultural by-products. Soy proteins are composed of a mixture of albumins and globulins, 90% of which are storage proteins with globular structure, consisting mainly in 7S (β-conglycinin) and 11S (glycinin) globulins (Kinsella, 1979). Globulins are protein fractions in which the subunits are associated via hydrophobic and hydrogen bonding (Thanh and Shibasaki, 1976). At alkaline pH next to 10, globulins dissociate, protein denatures, and interactions with additives are favoured due to an optimum unfolding of protein chains (Fukushima, 1969; Gennadios et al., 1993; Guerrero and de la Caba, 2010; Mauri and Añón, 2008).

On the other hand, gelatin is a protein derived from the chemical denaturation of collagen and it is a mixture of α-chains (one polymer chain), β-chains (two α-chains covalently crosslinked), and γ-chains (three covalently crosslinked α-chains) (Papon et al., 2007). Depending on the method in which the collagen is treated, two different types of gelatin can be produced. Type A gelatin (pl 6–9) is produced from acid-treated collagen, and type B gelatin (pl 5) is produced from alkali-treated collagen (Eysturskar et al., 2009; Stainsby, 1987). The amino acid composition of gelatin is very close to that of its parent collagen. It is mostly composed of glycine (Gly, 34%), proline and hydroxyproline (Pro + Hyp, 16%) imino acids, and alanine residues (Ala, 10%) (Gómez-Guillén et al., 2002; Karim and Bhat, 2009).

To date, many attempts have been made to modify the poor mechanical properties and relatively high moisture sensitivity of SPI films by physical, enzymatic, chemical and physicochemical methods (Park et al., 2001). However, as SPI contains 58% polar amino acids that cause its hydrophilicity, its moisture sensitive is difficult to eliminate (Rhim and Lee, 2004). Blending other natural...