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Ethyl vanillin incorporated chitosan/poly(vinyl alcohol) active films for food packaging applications

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ABSTRACT

Ethyl vanillin (EV) incorporated chitosan (CS)/poly(vinyl alcohol)(PVA) blend films of various ratios (1:3, 1:1 and 3:1) were prepared by solvent casting technique. The effect of EV on the mechanical, structural, barrier, optical, food compatibility and antibacterial properties of the CS/PVA films were investigated. Mechanical properties showed that addition of EV increased tensile strength of CPEV-1, CPEV-2 and CPEV-3 films by 39 %, 45 % and 86 %, respectively compared to CS/PVA matrix. The FTIR results confirmed the formation of a Schiff base (C═N) and intermolecular hydrogen bonds between CS, PVA, and EV. Incorporation of EV into CS/PVA matrix (i.e. CPEV) showed the marked influence on the water vapor transmission rates (WVTRs) and oxygen transmission rates (OTRs) and exhibited excellent UV barrier capability. Surface morphology of CPEV blend films becomes smooth, homogeneous and dense as visualized through scanning electron microscopy. Contact angle measurements demonstrated the increased hydrophobicity of CPEV blend films with increasing CS content. Strong antibacterial activity was exhibited by CPEV-3 blend films against both *E. coli (Escherichia coli)* and *S. aureus (Staphylococcus aureus)* bacteria. The overall migration values of CPEV blend films were 10^3 times lower than acceptable limits of 10 mg/dm^2. Therefore, CPEV blends have good potential to be considered as sources of active films for food packaging applications.

1. Introduction

The interest of developing bio-based films was intensified due to concerns of the limited natural resources, such as fossil fuels, and to reduce the impact of plastics on the environment (Sanches-Silva et al., 2014). In recent years, it is increasingly important to use biopolymers for the fabrication of active packaging films as an alternative to traditional plastic as consumers become more aware and increasingly prefer environmentally friendly packaging films (Atarés & Chiralt, 2016; Cerqueira, Souza, Teixeira, & Vicente, 2012). In this context, various researchers studied the development and application of biopolymer films, based on a variety of agricultural products and/or food waste (Aguirre, Borneo, & León, 2013; Leceta, Guerrero, Cabezudo, & de la Caba, 2013; SA, 2010; Sansone et al., 2014). Bio-based films have an intrinsic property to maintain quality and extend food shelf-life (Aguirre et al., 2013; Elsabee & Abdou, 2013). Several biopolymers such as starch (Fama, Rojas, Goyanes, & Gerschenson, 2005; Malhotra, Keshwani, & Kharkwal, 2015), cellulose derivatives (Dias, Müller, Larotonda, & Laurindo, 2011; El Halal et al., 2015), chitosan (Dash, Chiellini, Ottenbrite, & Chiellini, 2011; Huang, Huang, Huang, & Chen, 2007; Shahid & Mohammad, 2013), gums (Rao, Kanatt, Chawla, & Sharma, 2010; Tripathi & Katiyar, 2016), etc. have been used for various applications. Among these, CS based composite films are useful as bio-packaging material in the form of bioactive films for food preservation (Tharanathan, 2003). Furthermore, the bioactive CS films potentially serve as a vehicle to incorporate and enhance the food value along with other additives such as flavoring, coloring, antioxidant and antimicrobial agents (Fernandes, Freire, Silvestre, Pascoal Neto, & Gandini, 2011).

CS, the linear and partly acetylated (1–4)-2-amino-2-deoxy-β-D-glucan, is the main derivative of the natural polymer chitin, the second most abundant natural polysaccharide on the Earth, after cellulose. It exhibits unique properties, such as biocompatibility, antimicrobial activity, and biodegradability. Due to its remarkable film-forming ability, associated with its antimicrobial properties, chitosan has wide range of applications, namely in the field of food packaging (Fernandes et al., 2008, 2011), agriculture, drug delivery, wound healing, and pharmaceuticals (Dash et al., 2011). However, poor mechanical properties and

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