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Physical properties of chitosan-basil essential oil edible films as affected by oil content and homogenization conditions

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Abstract

This work studies the influence of basil essential oil, its content and the homogenization treatment on the physical properties of chitosan-based edible films. Two homogenization treatments were applied, without (H1) and with (H2) microfluidization (MF). Composite films were softer, less rigid and more stretchable than pure CH films. MF intensified these changes. H2 films showed microcracks due to the weak interactions between chitosan and oil, which affected their mechanical behaviour. In pure chitosan films, MF significantly increased water vapour permeability. Homogenization treatment greatly affected this property. Gloss was reduced by the essential oil addition, whereas MF tended to yield glossier films.

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Keywords: chitosan; essential oil; microfluidization; basil

1. Introduction

Edible films and coatings are prepared from biopolymers and are able to protect food products extending their shelf-life. The major constituents of these are polysaccharides, proteins and lipids. Chitosan (CH) is a cationic polysaccharide with excellent film-forming properties. It is obtained from chitin by deacetylation in the presence of alkali [1]. The combination of this hydrophilic constituent and some lipid could produce films with optimized characteristics [2]. Many lipids have been incorporated to composite films, mainly aiming to reduce the water vapour permeability of hydrophilic materials. Essential oils (EO) represent an interesting alternative to traditional ingredients, given the current research efforts on reducing the use of chemical additives in the food industry. Additionally, these plant extracts exhibit additional characteristics, such as antimicrobial and antioxidant effects [3]. Droplet size is a determining factor for emulsion stability, and affects other important properties of the emulsion, including its viscosity. Rotor-stator homogenizers are often used in the food industry, and are able to

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reach particle sizes in the range of 1 μm. This can be further reduced by applying an increased pressure in the system. Microfluidization (MF) can provide emulsions with narrower particle size distributions by submitting the emulsion to high shear stress in an interaction chamber. However, there are few studies dealing with the effect of microfluidization on the properties of the film-forming dispersions used to obtain edible films and coatings [4], The aim of this work is to study the influence of homogenization conditions and essential oil content on the physical properties (microstructure, mechanical behaviour, water vapour permeability and gloss) of CH:B edible films.

2. Materials and Methods

2.1 Materials

High molecular weight chitosan (CH) (Batch 12913CJ, Sigma-Aldrich Quimica, Madrid, Spain) was used to prepare the film-forming dispersions (FFD) (0.8 Pa s viscosity, at 2% w/w in 2% w/w glacial acetic acid). Basil (B) essential oil was provided by Herbes del Moli (Alicante, Spain), $Mg(NO_3)_2$ and P_2O_5 by Panreac Química, S.A. (Castellar del Vallés, Barcelona, Spain).

2.2. Preparation of the film-forming dispersions and casting of the films

High molecular weight CH (1 wt%), dispersed in and acetic acid solution (1 % v/w) and basil (B) (0.5 or 1 wt%) were mixed by two homogenization treatments, namely H1 and H2. FFD submitted to H1 were mixed by means of a rotor-stator homogenizer at 21500 rpm for 4 minutes. Treatment H2 consisted of H1 plus high-pressure homogenization at 165 MPa in a single pass by means of a Microfludizer ® M110-P processor. After homogenization, the formulations were degasified at room temperature with a vacuum pump.The FFD were cast at 5.6 mg solids/cm^2 and were poured onto a framed and leveled polytetrafluorethylene (PTFE) plate (diameter = 15 cm) and dried at room temperature and 60 % RH. The films were peeled off from the casting plates and conditioned for one week at 5ºC and 58%RH in a chamber containing an oversaturated solution of $Mg(NO_3)_2$.

2.3 Characterization of the film

2.3.1. Thickness

Film thickness was determined with a Palmer digital micrometer (Comecta, Barcelona, Spain) to the nearest 0.001 mm. Six were considered for WVP tests and four measurements were taken for the tensile tests.

2.3.2. Microstructure

Microstructure was observed by SEM in cross-sectioned cryofractured film specimens, using a JEOL JSM-5410 (Japan) electron microscope. The film samples were equilibrated in P_2O_5 to eliminate water, cryofractured by immersion in liquid nitrogen, and then mounted on copper stubs perpendicularly to their surface. After gold coating, the images were captured using an accelerating voltage of 10kV.

2.3.3 Mechanical properties

Mechanical properties were analysed by means of tensile tests (ASTM standard method D882, [5], to obtain stress-strain curves and mechanical parameters: elastic modulus (EM), tensile strength at break