INCORPORATION OF NANOHYDROGELS IN POLYSACCHARIDE-BASED FILMS: EFFECT ON PHYSIC-CHEMICAL PROPERTIES

A. I. Bourbon, L. C. Maciel, M. J. Costa, M. A. Cerqueira, A. A. Vicente

IBB – Institute for Biotechnology and Bioengineering, Centre of Biological Engineering, Universidade do Minho, Campus de Gualtar, 4710-057 Braga, Portugal

isabelbourbon@deb.uminho.pt

Edible films based on renewable materials have received great attention as potential packaging materials, mainly because such biodegradable films are considered to be a promising solution to environmental issues. Edible films can be used to: improve food quality, enhance sensory properties and increase the shelf life of various food products. Carboxylmethylcellulose (CMC) is an anionic polysaccharide, derivates from cellulose and is widely used to improve products and processing properties in several applications (e.g. food, cosmetic, and pharmaceutical industry). Besides acting as a protective barrier, edible films can be used as carrier of bioactive compounds, enhancing the functional properties of the food product promoting their health benefits. In this work, CMC-based films containing protein nanohydrogels (composed by lactoferrin (Lf) and Glycomacropeptide (GMP) with a hydrodynamic diameter around 170 nm) were produced and their mechanical, barrier properties (water vapour, oxygen and carbon dioxide permeabilities) and watter afinity (moisture, solubility and contact angle) were evaluated. The addition of Lf-GMP nanohydrogels to CMC-based films influenced their tensile strength and the elongation-at-break. The incorporation of Lf-GMP nanohydrogels also lead to a decrease of ($p<0.05$) gas permeability (water vapor permeability (from $8.33 \times 10^{-11} \pm 2.48 \times 10^{-12}$ to $6.38 \times 10^{-12} \pm 2.30 \times 10^{-12}$ for CMC edible films without and with nanohydrogels, respectively) and oxygen (from $2.41 \times 10^{-13} \pm 9.57 \times 10^{-14}$ to $1.47 \times 10^{-13} \pm 5.83 \times 10^{-14}$ for CMC edible films without and with nanohydrogels, respectively) and carbon dioxide (from $1.27 \times 10^{-13} \pm 2.84 \times 10^{-14}$ to $8.63 \times 10^{-14} \pm 3.86 \times 10^{-15}$ for CMC edible films without and with nanohydrogels, respectively) permeability). Scanning electronic microscopy allowed to visualize the morphological structure of the films, mainly the homogeneous distribution of the nanohydrogels in the film matrix (Figure 1). The addition of protein-based nanohydrogels also affects the hydrophobicity of CMC films: incorporation of Lf-GMP nanohydrogels significantly increases moisture content (from 16.80 ± 1.71 to $22.10 \pm 4\%$ (w/w) for CMC edible films without and with nanohydrogels, respectively), decrease the solubility (from 66.81 ± 5.88 to $53.01 \pm 4\%$ (w/w) for CMC edible films without and with nanohydrogels, respectively) and increase the contact angle (from 45.36 ± 2.98 to $82.76 \pm 2.85\,°$ for CMC edible films without and with nanohydrogels, respectively). Results showed that it is possible to incorporate protein-based nanohydrogels in edible films; this work contributes to the establishment of an approach to optimize edible films after the addition of nanostructures promoting new and enhanced functionalities of packaging materials.

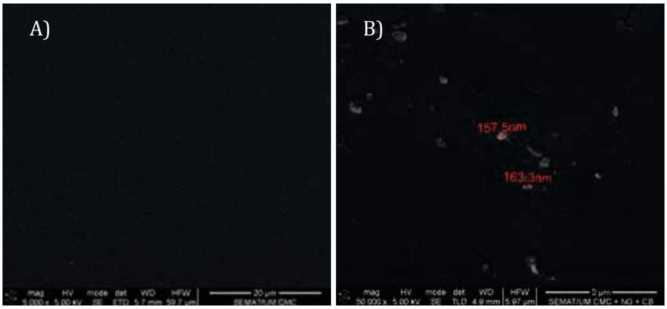

Figure 1. Morphology of CMC edible films: A) without nanohydrogels and B) with Lf-GMP nanohydrogels.