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Effect of EDC/NHS and L-cysteine addition on mechanical, thermal and morphological properties of biobased gliadin films

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Abstract – In this study gliadin solutions previously crosslinked by 1-(3-dimethylaminopropyl)-3-1-ethylcarbodiimide hydrochloride/N-hydroxysuccinimide (EDC/NHS) and *L*-cysteine were casted and the film properties studied through mechanical behaviour (Young's Modulus and Elongation at Break), thermal (DSC, TGA), swelling and water solubility, FTIR measurements and Scanning Electron Microscopy (SEM). According to our results, gliadin films at all composition have shown influence of chemical agents which seemed to react by different mechanisms. The mechanical, water absorption, and swelling properties of gliadin-based films appeared to be dependent on their three-dimensional network structure and on the interaction between proteins, plasticizers, and other functional agents.

Edible films from plant materials have already been reported to have potential uses in food protection and preservation. These films are used in food packaging and coating of fruits and vegetables and are of great interest due to their environmental benefits Biodegradable films from plant proteins have possible potential uses in the agricultural research, pharmaceutical industry and also more recently on biomaterials applications.[1] Gliadin is a biodegradable, biocompatible globular protein obtained by isolation from wheat flour. This biopolymer shows excellent film- and coating-forming properties when cast from organic solutions.

The functionality of edible coatings depends on many factors, and it has been usually predicted by using stand-alone films as a model. Factors affecting edible film performance have been extensively studied. Many of these studies elucidated how composition, preparation, and storage conditions affected film barrier and mechanical properties. These works have shown the importance of polymer cohesion on film properties and the role of different components on polymer cohesion.[2,3]

In this work, solutions were prepared by adding the protein to distilled water (9 % wt protein) with different amounts of glycerol (5, 10, 15 and 20 % w/w of protein). The pH of the dispersion was adjusted and kept constant at pH 4 prior to addition of EDC/NHS. Different proportions of EDC/NHS, ranging from 1.5 to 12 % (w/w of gliadin) were added to the solutions, which were heated up to 55 ºC, to achieve protein solubilization, with gentle stirring and kept at this temperature for 1 hour. A similar procedure was then carried out using solutions treated with *L*-cysteine, in which the pH was maintained at between 10-11. For film analysis the solution was cast onto PTFE dishes and the water was evaporated overnight at 40° C. As a way to facilitate data interpretation, system A refers to gliadin without any chemical modification, system B refers to gliadin/EDC/NHS, and system C refers to gliadin/*L*-cysteine. According to our results and mainly by SEM, it was possible to observe that system B has presented higher porosity which is directly related to solubilitly and swelling behaviour. These behaviour could be also be related to mechanical and thermal analysis showing that gliadin films were extremely dependent on components concentration and interaction between plasticizer and protein before and after film evaporation.

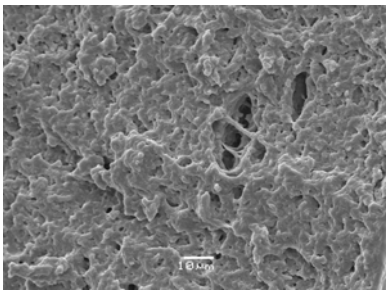

Figure 1: SEM of gliadin/EDC-NHS (system B) cross-section at 10 % of glycerol (w/w).

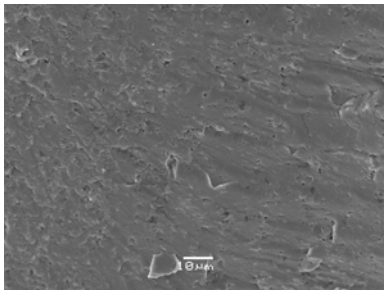

Figure 2: SEM of gliadin/L-cysteine (system C) cross-section at 10 % of glycerol (w/w).

[1] Singh, N.; Georget, D. M. R.; Belton, P. S.; Barker, S. A, *J. Agric. Food Chem.* 57 (2009), 4334–4341.

[2] Fernandez-Saiz, P.; Lagar J. M.; Ócio, M. J. *J. Agric. Food Chem*. 57 (2009), 3298–3307.