

# DEVELOPMENT OF ACTIVE BIOPLASTICS BASED ON WHEAT PROTEINS AND NATURAL ANTIMICROBIALS FOR FOOD PACKAGING APPLICATIONS

## ABSTRACT

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This PhD dissertation focuses on the development of renewable and biodegradable active films based on chemically-modified wheat gliadin proteins endowed with antimicrobial capacity owing to the incorporation of naturally-occurring bioactive compounds, namely cinnamaldehyde, natamycin, and lysozyme.

Gliadin proteins were treated with cinnamaldehyde at acidic pH and films were produced by casting. The resulting protein-based films presented improved functional properties (mechanical, barrier, and water resistance), and biochemical evidence of the formation of a more compact network whose degree of cross-linking increased with the amount of cinnamaldehyde incorporated into the gliadin-ethanolic solution.

Free cinnamaldehyde not participating in the cross-linked reaction remained entrapped in the protein matrix at low relative humidity conditions. The sensitivity of the films to moisture owing to the hydrophilic character of gliadins provided a trigger and control mechanism for the release of cinnamaldehyde in moderate and high relative humidity environments, similar to conditions occurring in packaged food products.

The antimicrobial properties of the films developed were tested *in vitro* by vapor diffusion assays against common food spoilage fungi (*Penicillium expansum* and *Aspergillus niger*), showing great effectiveness. Application of these active films to the preservation of two foodstuffs, sliced bread and cheese spread, gave promising results, lengthening fungal growth lag phase and minimizing fungal growth extension.

Neither the improved functional properties nor the antimicrobial capacity hampered the inherent biodegradability of the gliadin proteins, and the resulting films were compostable, which represents a suitable and environmentally-friendly end-of-life option.

The proteinaceous matrices developed showed different swelling and water diffusivity depending on the degree of cross-linking achieved, which makes them ideal substrates for the development of carrier and release systems for active compounds. Accordingly, lysozyme and natamycin were incorporated into the cross-linked gliadin matrices. Functional, release, and antimicrobial properties were evaluated, and the results indicated the great potential of these novel matrices for active food packaging applications.