Evaluation of Canola Protein Functionality in Mixed Food Systems

By

Florence Ojiugo Uruakpa

A Thesis
Submitted to the Faculty of Graduate Studies
In Partial Fulfillment of the Requirement
for the Degree of

DOCTOR OF PHILOSOPHY

Food and Nutritional Sciences
University of Manitoba
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THE UNIVERSITY OF MANITOBA

FACULTY OF GRADUATE STUDIES

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ABSTRACT

Oilseed proteins contribute useful functionality to food systems. Knowledge of the molecular interactions between plant proteins such as commercial canola protein isolate (CPI) and hydrocolloids such as κ-carrageenan (κ-CAR) and guar gum will allow the manipulation of physical and textural properties of mixed biopolymers by adjusting the interaction in a desirable way. This research investigates the molecular interactions involved in gelation and emulsification of these CPI-hydrocolloid systems. The objectives were to: a) determine the functional and physicochemical properties of CPI-κ-CAR and CPI-guar gum mixtures; b) determine the type and degree of interactions between CPI and κ-CAR or guar gum based on protein conformational changes assessed by differential scanning calorimetry, fluorescence spectroscopy and microscopy; and c) establish optimum conditions for gelation and emulsification of these systems. Gelling characteristics and emulsifying properties were evaluated using dynamic rheology and spectroturbidimetry, respectively. This study has 1) characterized the gel properties of CPI-κ-CAR and CPI-guar gum mixtures using dynamic rheology and microscopy; 2) optimized conditions for specific functional properties such as network and emulsion formation. Optimum conditions for gelation of CPI-κ-CAR mixtures were pH 6, 3% (w/v) κ-CAR, 0.05 M NaCl, 15% (w/v) CPI; whereas those for CPI-guar gum mixtures were pH 10, 1.5% (w/v) guar gum, 0.05 M NaCl, 20% (w/v) CPI. Electrostatic complexing and synergistic interaction contributed to the formation of strong and elastic CPI-κ-CAR gels. The synergistic behaviour was supported by the microstructural data of gel networks. Furthermore, optimum conditions for CPI-κ-CAR-stabilized emulsions were pH 6, 1% (w/v) κ-CAR, 0.25 M NaCl, 10% (w/v) CPI; whereas those for CPI-guar

gum-stabilized emulsions were pH 10, 3% (w/v) guar gum, 0.25 M NaCl, 10% (w/v) CPI; 3) confirmed that hydrophobic interactions, hydrogen bonding and disulfide linkages are the main molecular forces involved in the formation and stabilization of CPI-κ-CAR and CPI-guar gum gels and emulsions; 4) reported improvements in the emulsifying properties and surface hydrophobicity of these CPI-hydrocolloid mixtures, when compared to CPI alone. Protein-polysaccharide interactions give a realistic indication of plant proteins behaviour in food systems and provide useful information for the development of functional canola protein products.

INTRODUCTION

Plant protein functionality in food systems can be affected by other components in that system. Studies on protein-polysaccharide interactions have shown that under some conditions, these interactions can result in improved gelation (Samant et al., 1993) and emulsification properties (Ledward, 1994). Understanding the interactions between components in food systems is a prerequisite for the incorporation of plant proteins such as CPI into conventional foods or the development of new foods. Interactions between proteins and polysaccharides may result in complex formation, homogeneous solutions and incompatibility (Tolstoguzov, 1998). Industrial significance of interactions between proteins and polysaccharides for protein recovery, protein stabilization and food texture modification has been documented (Ledward, 1979). The mechanisms of forming protein gelling systems by these interactions (Stainsby, 1980) and designing of new food systems (Tolstoguzov, 1995) based on these interactions have been reviewed. The type of association does not necessarily determine the contribution to the functional properties of the food. For example, thermally stable protein gels have been produced through electrostatic interactions between sodium alginate and sodium caseinate (Tolstoguzov, 1991). However, studies with canola protein revealed that the addition of low concentrations of guar gum improved protein gel characteristics; but not when methylcellulose or sodium alginate was included (Arntfield and Cai, 1998).

Canola is the term registered and adopted in Canada to describe the oil obtained from the seed cultivars *Brassica napus* and *Brassica campestris*. In 1986, the term canola was amended to refer to *B. napus* and *B. campestris* (now *B. rapa*) cultivars containing <2% erucic acid in the oil and <30 μmol/g glucosinolates in the air-dried, oil-