

# 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  
Winnipeg, Manitoba

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## ACKNOWLEDGEMENT

I owe all allegiance and reverence to the Almighty God, my greatest inspiration. I am indebted to my supervisor, Dr. Susan D. Arntfield, for her painstaking guidance and encouragement that led to the successful completion of my doctoral program. Her academic assistance is outstanding. Profound appreciation is extended to my mentor, Dr. Rotimi E. Aluko, for his superb support that steered me to greater heights. Words are not enough to describe the solid assistance he rendered during the writing of the thesis. I thank other members of my committee, Dr. Anne H. Ismond, Dr. Trust Beta and Dr. Roman Przybylski for their help and suggestions. Special appreciation is extended to Dr. Harry Sapirstein, for his kind gestures and motivation.

Funding of this research through Natural Sciences and Engineering Research Council of Canada grant to my supervisor is greatly appreciated. Financial assistance (James W. Barlow Graduate Fellowship) from the University is acknowledged. The technical assistance from Aniko Bernatsky, Wayne Johnson, Dr. N. Halden, Ron Chapman, Guillermo Bellido and Parthiban Muthukumarasamy was instrumental to the completion of this study. To all my friends, well-wishers and the staff of Food Science department, I extend my sincere gratitude for their encouragement.

I say to my dotting and graceful husband, Geoffrey Ndubuisi Nweke, your understanding and patience gave me the zest to excel. Sweetness, you complete me. The prayers and encouragement of my other loved ones, Ngozi Uruakpa, Betty Chinke, June Pearcey and Loveth Ekwemalor are appreciated. The endless love and unceasing prayers of my sweet and caring Mom, Nwadiuto Virginia Uruakpa, serve as my spring board to success. *I dedicate this piece to my Mom and my husband.*

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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  $\kappa$ -carrageenan ( $\kappa$ -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- $\kappa$ -CAR and CPI-guar gum mixtures; b) determine the type and degree of interactions between CPI and  $\kappa$ -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- $\kappa$ -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- $\kappa$ -CAR mixtures were pH 6, 3% (w/v)  $\kappa$ -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- $\kappa$ -CAR gels. The synergistic behaviour was supported by the microstructural data of gel networks. Furthermore, optimum conditions for CPI- $\kappa$ -CAR-stabilized emulsions were pH 6, 1% (w/v)  $\kappa$ -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- $\kappa$ -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  $\mu\text{mol/g}$  glucosinolates in the air-dried, oil-