GRADUATE AND POSTDOCTORAL STUDIES

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FINAL ORAL EXAMINATION

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DOCTOR OF PHYLOSOPHY

OF

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DEPARTMENT OF FOOD SCIENCE AND AGRICULTURAL CHEMISTRY

FTIR INVESTIGATIONS OF WHEY PROTEIN INTERACTIONS IN RELATION TO MODEL FOOD SYSTEMS

DATE: August 7th 2015
TIME: 9:15 a.m.

MACDONALD STEWART BUILDING, ROOM MS2-022
McGill University, Macdonald Campus

COMMITTEE:

Dr. T. Geary	(Pro-Dean, Institute of Parasitology)
Dr. V. Yaylayan	(Chair, Department of Food Science and Agricultural Chemistry)
Dr. A.A. Ismail	(Supervisor, Department of Food Science and Agricultural Chemistry)
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Dr. H. Ramaswamy	(Internal Member, Department of Food Science and Agricultural Chemistry)
Dr. V. Orsat	(External Examiner, Department of Bioresource Engineering)

Dr. Marshall Kreiswirth, Dean of Graduate and Postdoctoral Studies

Members of the Faculty and Graduate Students are invited to attend

ABSTRACT

The research presented in this thesis centered on one of the most important food proteins, the bovine whey protein β-lactoglobulin. Thermal stability studies of the two main genetic variants of β-lactoglobulin (A and B) as well as AB mixtures from different sources, investigations of their interactions with glycomacropeptide (GMP), and the study of the interactions of β-lactoglobulin with other ingredients in a "high-protein cookie" model food system were conducted by Fourier transform infrared (FTIR) spectroscopic techniques. Although variants A and B of β-lactoglobulin differ from each other only at two amino-acid positions (64 and 118, where Asp and Val in the A variant are substituted by Gly and Ala, respectively, in the B variant), variable-temperature (VT)-FTIR studies in conjunction with two-dimensional correlation spectroscopy (2D-COS) demonstrated these differences had a much larger impact on β-lactoglobulin's thermal behavior than differences in the conditions that the protein had been subjected to during the isolation and purification procedures. Furthermore, VT-FTIR studies of β-lactoglobulin AB from different sources (undefined mixtures of variants A and B originating from pooled milk samples) yielded inconsistent results, which is attributable not only to the different thermal behavior of the two variants but also to their interactions to form AA, BB, and AB dimers. Extension of these VT-FTIR studies to binary mixtures of GMP and β-lactoglobulin A, B, and AB from the different sources and at different ratios showed variable effects of protein-GMP interactions on the protein's thermal behavior. In the case of β-lactoglobulin A, its denaturation temperature in the mixtures with GMP was lower than that of the pure protein whereas the opposite trend was observed for β-lactoglobulin B and the AB mixtures. To study the interactions of β-lactoglobulin with other food ingredients, a "high-protein cookie" model food system was formulated in consultation with the R&D center of a leading manufacturer of high-protein nutritional products. The spatial distribution of the protein, lipid, and carbohydrate ingredients in unbaked and baked model cookies was examined on the micron scale by employing focal-plane-array (FPA)-FTIR imaging microscopy in the attenuated total reflectance (ATR) mode, representing the first application of this "chemical imaging" technique to the study of a model food system. As such, it was necessary to develop a multi-step protocol enabling the extraction of relevant information from hyperspectral data sets comprising thousands of spatially resolved FTIR spectra of each imaged sample. In addition, films cast from binary mixtures of β-lactoglobulin and each of the other ingredients at the concentration ratio employed in the "high-protein cookie" formulation were examined by FPA-FTIR imaging

microscopy before and after heating in order to investigate the effects of the protein's interactions with these ingredients on its secondary structure and thermal stability. These studies suggest the potential future role of FPA-FTIR imaging microscopy as a practical technique for use by the food industry to gain a better understanding of the behavior and interactions of food components that ultimately have a major impact on the quality of food products.

CURRICULUM VITAE

UNIVERSITY EDUCATION

Ph. D. in Food Science, McGill University, 2009-to date

Master in Science in Microbiology, Universidad Autonoma de Nuevo Leon

Bachelors in Pharmacological Biologist Chemist, Universidad Autonoma de Coahuila

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PUBLICATIONS

Valtierra Rodriguez D., Heredia N., Garcia S. and Sanchez E. (2010). Reduction of Campylobacter jejuni and Campylobacter coli in Poultry Skin by Fruit Extracts. *Journal of Food Protection*: 73.3, 477-482.

CONFERENCE PRESENTATION

Poster presentations

Valtierra D., Sedman J. & Ismail A. (2012). Examination of the Secondary Structure and Thermal Stability of Bovine β–Lactoglobulin A Obtained by Different Isolation Methods. *12th Annual Meeting of the Institute of Food Technologists*, Las Vegas, Nevada, USA.