

Ontario Cereal Industry Research Council



Progress Report April 2009-January 2010

Greetings!

Thank you!

- * We would like to thank C.W. Brabender Measurements, Inc. for the generous donation of laboratory equipment. Please take the time to visit their website at www.Brabender.Com

Hello,

It has been very busy lately in the Cereal Science and Technology Laboratory here at Guelph. The arrival of new students allows for broader research themes to be explored by our laboratory group. In this newsletter you will be updated on the current research focus of Dr. Koushik Seetharaman's Cereal Science and Technology Laboratory group.



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The Cereal Science and Technology Research Group. Photo taken Dec. 2009
Standing second row from left; Bruce Manion , John Melnyk, Koushik Seetharaman, Neelam Dhull, Hongkai Ma, Igor Guzar, Avi Goldstein
Standing front row from left: Simarata Dhillon, Renuka Waduge, Falguni Chahan, Saima Inayat, Sanaa Ragae, Azadeh Vatandoust

News!

Save these dates!

Industry Day: March, 2010

Fundamentals of Wheat Flour Properties:
Summer, 2010

Congratulations!

Simarata Dhillon successfully completed her MSc research program. Well done!

MITACS scholarship winners

Ms. Carolyn Challacombe: Industrial partner – Kraft Inc

Ms. Brittany Huschka: Industrial partner – Coasun Inc



The Food Science building at the University of Guelph

Research Grants

In Progress (Total \$529,000)

- 2009. Optimization of oat and barley β -glucan bioactivity in cereal-based bakery products. \$185,000
- 2008. NSERC. Understanding Starch Granular Architecture. \$44,000
- 2008. NSERC Instrumentation Grant. Acquisition of a Konica Minolta Multifunctional Top Port Spectrophotometer (Model CM-3500d) to investigate starch granule architecture. \$22,000
- 2008. OMAFRA. Exploration of soy isoflavone-enriched bread in relation to improved formulation and sensory attributes and cardiovascular disease risk. \$50,000
- 2008. OMAFRA. Understanding the behaviour of oil-water-monoglyceride nanostructures in baked food matrices and evaluating human health benefits following consumption of these products \$228,000

Submitted (Total \$1,841,000)

- 2009. OMAFRA. Characterizing the sensory attributes of whole grain wheat-based products and the phenolics associated with these attributes \$191,500
- 2009. OMAFRA. Development of an oxidative process for reducing the surface pigmentation of red wheat. \$119,500
- 2009. NSERC-CRD Understanding granular architecture of starch to design structures in baked product matrices \$418,000
- 2009. OMAFRA. Modulating starch digestibility in baked products: Effects of granule architecture and hydrothermal treatments on polymer structure/network and digestibility (\$207,000).
- 2009. OMAFRA. Utilization of hemp for food use : Leveraging the nutritional and functional ingredients of hemp (\$180,000)
- 2009. OMAFRA. Characterizing acrylamide formation kinetics in a commercial oven to develop strategies to mitigate acrylamide formation in baked products (\$222,000).
- 2009. CAAP. Enhancing Wheat Protein Quality Analysis for the benefit of the entire value chain (\$262,000)
- 2009. CAAP. Growing Wheat and Wheat-Based Healthful Baked Foods : A Value Chain Approach (\$241,000)



Research Team

Staff (OCIRC Funded)

Dr. Sanaa Ragaee

Dr. Ragaee received her PhD in the Department of Applied Microbiology and Food Science, at the University of Saskatchewan, Canada. Her expertise is in the area of non-starch polysaccharides and health. Dr. Ragaee is the Research Manager and team leader responsible for managing the research projects, supervising and training graduate students, research assistants and post doctors joining the team.

Dr. Neelam Dhull

Dr. Dhull is a post doctorate scholar. She completed her Ph.D. program at the Guru Jambheshwar University of Science and technology, Hisar (India). Her Ph.D thesis was on 'Development and Evaluation of Nutraceutical Bakery Products. Her expertise is in developing functional bakery products. She manages the bake lab and research programs related to grain quality.

Dr. Anita Mofidi

Dr. Mofidi is a new post doctorate scholar. She received her PhD in the Department of Human Health and Nutritional Science at University of Guelph. Her Ph.D thesis was on the impact of ingestion of different types of bread of varying composition on the biomarkers related to glucose metabolism in overweight and obese adults. She is currently studying product development using fiber of different sources.

Mr. Igor Guzar

Igor has completed his BSc. in Food Science from the University of Guelph. He just started as a research assistant in the cereals program, he is applying next fall for a Master Degree with our group.

Graduate Students (OCIRC funded)

Ms. Falguni Chauhan (MS)

Thesis Title: Exploring the chemistry of homoglucon polymer interaction with iodine at low moisture contents.

Brief outline of area of research: Previous work to understand starch structure used iodine in solution together with potassium iodide. In Falguni's studies, she is using iodine vapor directly to react with starch structures at low moisture contents. The helical complex formation between iodine and a linear glucon polymer has been the cornerstone of research on starch in our laboratory. This reaction and resultant color/absorbance properties have been used to interpret many different properties and attributes of starch. The objective of her study is to investigate the interaction of iodine vapor with linear and branched homo-glucon polymers. Using iodine as a tool provides a novel technique to investigate and understand starch structure-function relationships.

Expected Completion Date: December 2009

Bruce Manion (PhD)

Thesis title: Using starch modification techniques on starches of different botanical sources with iodine as a marker to understand starch granule architecture

Brief outline of area of research: This research involves using common starch modification processes at varying degrees such as cross-linking, substitution (phosphorylation, hydroxypropylation, and acetylation), and cold-swelling/solubilization techniques on starches of different botanical origins including wheat, corn, waxy corn, high amylose corn, potato, waxy potato and tapioca starches. The starches will then be analyzed based on their ability to bind iodine, crystallinity, pasting, granule swelling, gel rheology and microstructure. In addition, it is necessary to develop a method to quantify iodine in starch and relate this information to the colour changes observed in starches exposed to iodine. It is believed the known chemical changes resulting from the starch modification procedures will allow new light to be shed on the original organization and architecture of the starch granules, which will help in the future to optimize starch modification techniques to develop starches

Research Team Cont.

with greater functionality in foods.

Expected Completion Date: Sept, 2012

Mr. Komeine Nantanga (PhD)

Komeine started his PhD in May 2009. He completed his MSc. in Food Science at the University of Pretoria, South Africa. Prior to coming here, he worked as a research technician and instructor in the Biochemistry department at the University of Namibia. Komeine's research will focus on strategies to modulate the digestibility of starch in baked products.

Expected Completion Date: May, 2012

Funded through other grants

Ms. Renuka Waduge (PhD; NSERC and Vitamin Scholarship)

Renuka Waduge is a Ph. D. Candidate. She is in the second year of her program and is studying the structural development of Canadian grown wheat starch granules during maturity. She obtained her Master's degree in Food Science from the Memorial University, Newfoundland, Canada, and the B. Sc. Honors degree in Chemistry from the University of Sri Jayewardenepura, Sri Lanka. She studied the annealing of barley starch as her M. Sc. Research. With a strong knowledge in cereal starches and experience in X-ray, SEM, DSC, Microscopic, spectroscopic, and chromatographic techniques, she brings an added value to our lab.

Expected Completion Date: Dec, 2011

Mr. Avi Goldstein (MS; OMAFRA funded)

Thesis Title: Investigating the role of monoglyceride-stabilized oil in water emulsion in sensory and textural attributes of baked food products.

Brief Description : Identify the role of monoglyceride – stabilized oil in water emulsions on final baked product attributes, and identify specifically how the emulsion interacts with major products components (starch, water, gluten). In order to address the primary research focus a variety of food systems will be created with differing percentages of monoglyceride-stabilized oil and major product components. Food systems to be evaluated will be systems in which the roles of major product components are well understood. Systems studied will include puff pastries, cookies, and pound cakes.

Expected Completion Date: May, 2011

Ms. Brittany Huschka (MS; Industry funded)

Thesis Title: Understanding the behaviour of a monoglyceride- stabilized oil in water emulsion with multi-components of a baked food matrix.

Brief Description: Comparing the interaction of a monoglyceride-stabilized oil in water emulsion to other shortenings, oil, and oil, monoglyceride mixtures with flour, gluten and starch. This will be investigated by determining the thermal and rheological properties of the monoglyceride stabilized emulsion and the specific food matrix component following different hydro-thermal treatments.

Expected Completion Date: April, 2010



Research Team Cont.

Ms. Carolyn Challacombe (MS; MITCAS funded)

Thesis Title: “Characterizing the sensory attributes of red and white wheat, their brans and whole grain products made using red or white wheats.”

Brief Description: Red wheat is the predominant wheat grown in Ontario. However, red wheats impart an off-flavor to whole grain products. The purpose of this research is to gain knowledge of the sensory attributes including the nature and reasons of the off-flavours of red wheats compared to white wheats. The data collected will lead to developing strategies to formulate whole grain products with improved sensory and textural attributes.

Expected completion date: April ,2011.

Mr. John Melnyk (MS ; MITACS Funded)

Thesis Title: Developing an analytical tool to classify wheat gluten protein quality at early stages of breeding.

Brief Description: A technique will be developed to classify wheat gluten protein quality at early stages of breeding with sample sizes as small as 20 grams. The tool that will be used for the study is known as a Gluten Peak Tester (GPT). The objectives of the study are to; define the measurement parameters and settings in the GPT to measure gluten properties; variables to be tested include water to flour ratio, temperature of measurement, and the rpm of the spindle; Validate the optimal settings using different control wheat varieties with known properties and functionality; Evaluate gluten protein quality on early generation breeding lines. The partner company, Hyland Seeds, will benefit from the internship because they will be able to screen for protein quality in earlier stages of breeding using smaller sample sizes. This will allow them to retain seeds that possess unique protein quality attributes for future development work.

Expected Completion Date: Apr, 2011

Azadeh Vatandoust (MS; OMAFRA New Direction Grant)

Thesis title: Optimization of oat and barley β -glucan bioactivity in cereal-based bakery products

Brief outline of area of research: This research involves localizing the sources and mechanisms of action of β -glucan breakdown in wheat-flour based products .As well, we will focus on developing strategies to maintain high MW β -glucan in foods. This research will provide supporting evidence for a health claim for cereal β -glucan products in Canada.

Expected Completion Date: Aug, 2011

Simarata Dhillon (PhD ; OMAFRA funded)

Thesis title: Characterizing the sensory attributes of whole grain wheat-based products and the phenolics associated with these attributes

Brief outline of area of research: In a nutshell, we will be studying the off-flavours in whole-wheat baked products (e.g. breads) and investigating the causative volatile and non-volatile phenolic compounds responsible for these flavours. These will be correlated with the sensory attributes of these products. The findings will be used to suggest changes in the baking process and/or breeding programs in order to overcome the problem of off-flavouring in whole-wheat products.

Expected Completion Date: Dec, 2012

Research Focus

Research in our laboratory is focused on different aspects of cereal grains including grain quality, functionality in food products and health attributes derived from grains and grain-based foods. A significant focus of research is on Ontario grown wheats. Some of the current research foci are as follows.

Starch Granular Structure & Architecture

- Explore starch granular architecture during starch synthesis
- Adapt new techniques to explore granular architecture of starches including X-ray Diffraction, Atomic Force Microscopy, Tip Enhanced Imaging with Raman Spectroscopy and Atomic Force Microscope etc.
- Understand structural differences in starches from different botanical sources

Processing

- Design structures in baked products to improve shelf life and reduce glycemic response
- Develop tools to monitor polymobility in products to predict shelf life
- Develop a process map by monitoring polymer mobility during real time baking
- Adapting processes to create products with improved nutritional and textural attributes
- Investigate the relationship between product structure and starch digestibility following specific hydrothermal treatments

Grain Quality

- Functional components in wheat
- Adapting functionality of Ontario-grown wheat for baked products

Research Infrastructure

Research Instrumentation present in Cereal Science and Technology Laboratory

High Performance Liquid Chromatography
 UV-Vis Spectrophotometer
 Rapid Visco Analyzer
 Micro Visco Amylograph (Donated by Brabender)
 Texture Analyzer
 Gluten Peak Tester
 Glutograph (Donated by Brabender)
 Heavy duty modified Farinogram (Donated by Brabender)
 Hybrid Oven
 Milling and Baking Equipment

Shared research instrumentation

X-Ray Diffractometer
 Differential Scanning Calorimeter
 Light Microscope
 Scanning Electron Microscope
 Confocal Scanning Laser Microscope
 Rheometer



Papers submitted or in preparation

Molecular interactions in starch-water systems: The effect of increasing starch concentration. Avi Goldstein, Komeine Kotokeni Mekondjo Nantanga, Koushik Seetharaman (Journal of cereal chemistry)

Iodine absorption properties and its effect on the crystallinity of developing wheat starch granules. R.N. Waduge, S. Xu and K. Seetharaman (carbohydrate polymers)

Effect of different sources of potential prebiotics on starch digestibility (Food Chemistry), (S. Ragae, N.Dhull, I.Guzar and K. Seetharaman).

Cellulosic Fibre Interaction with Starch, Gluten, and Wheat Flour. (A. Goldstein, L. Ashrafi and K. Seetharaman).

Interactions of a novel monoglyceride-stabilized oil in water emulsion with wheat flour, starch and gluten. Brittany Hushcka, Carolyn Challacombe, Alejandro Marangoni and Koushik Seetharaman.

Comparison of oil, interesterified soy shortening, and a monoglyceride structured shortening alternative on wheat dough rheological properties and starch pasting. Brittany Hushcka, Carolyn Challacombe, Alejandro Marangoni and Koushik Seetharaman.

Effect of anions and cations of the Hofmeister series on gluten aggregation. John Melnyk, Jens Dreisoerner and Koushik Seetharaman.

Interaction of iodine with different homo-glucan structures. Falguni Chauhan and Koushik Seetharaman

Evidence of polymer mobility in a starch lintner. Falguni Chauhan and Koushik Seetharaman.

Use of iodine in investigating the differences in pasting properties of starches from various botanical sources. Simarata Dhillon and Koushik Seetharaman.

Investigating the swelling of starch granules from different botanical sources using iodine as a marker. Simarata Dhillon and Koushik Seetharaman

Texture and rheology of starch gels containing iodine. Simarata Dhillon and Koushik Seetharaman

Effect of Potato Peel Incorporation on the Technological and Antioxidant Properties of Bread. Neelam Dhull, Venkat Rao, Koushik Seetharaman

Nutritional and Sensorial Evaluation of Protein rich Soy Bread. Neelam Dhull, Lisa Duizer and Koushik Seetharaman

Characterization of a rice-based pasta: comparison between conventional and extrusion-cooking pasta-making process (Alessandra Marti, M.Ambrogina Pagani, Koushik Seetharaman)

Segmental mobility of polymers of starch isolated from rice pasta at low moisture content (Alessandra Marti, M.Ambrogina Pagani, Koushik Seetharaman).

New approaches for semolina characterization (Alessandra Marti, M.Ambrogina Pagani, Koushik Seetharaman).

New approaches for Durum Wheat pasta characterization (Alessandra Marti, M.Ambrogina Pagani, Koushik Seetharaman).



Recent Presentations



Use of iodine vapor as a tool to understand the wheat starch granule structure during maturity (AACC, September 2009, Annual Meeting, Baltimore, Maryland, USA).

Use of iodine vapor as a tool to understand the structural development of starch granule during. (June 2009, IWQC IV, Saskatoon, Saskatchewan, Canada).

Segmental mobility of polymers in heat-moisture treated normal and waxy potato starch granules (AACC, September 2009).

Interactions of a novel monoglyceride-stabilized oil in water emulsion with wheat flour, starch and gluten (CIGR, August 2009).

Time-temperature effects on the stability of a monoglyceride-oil-water shortening alternative (AOCS, May 2009)

Effect of monoglyceride-stabilized oil in water emulsion on dough rheological properties (IFT, 2009).
Cellulosic Fibre Interaction with Starch, Gluten, and Wheat Flour (IFT,2009)

Interaction of iodine with different homo-glucan structures (AACC 09).

New approaches for semolina characterization (AACC, 09).

Characterization of a rice-based pasta: comparison with conventional semolina pasta (June 2009, IWQC IV, Saskatoon, Saskatchewan, Canada).

Abstracts Submitted for Future Conferences

Effect of salt, alcohol, or acid on gluten aggregation (IFT 2010).

Comparison of oil, interesterified soy shortening, and a monoglyceride structured shortening alternative on wheat dough rheological properties and starch pasting (AOCS 2010).

Effect of Potato Peel Incorporation on the Technological and Antioxidant Properties of Bread (IFT, 2010).

Evaluation of a new Tool to Discriminate Wheat Protein Quality (IFT 2010).

The effect of common baking ingredients on gluten development in dough studied with Fluorescence Spectroscopy (AACC 2010).

Effect of wheat bran type and particle size on *in vitro* starch digestibility of wheat baked products (AACC 2010).