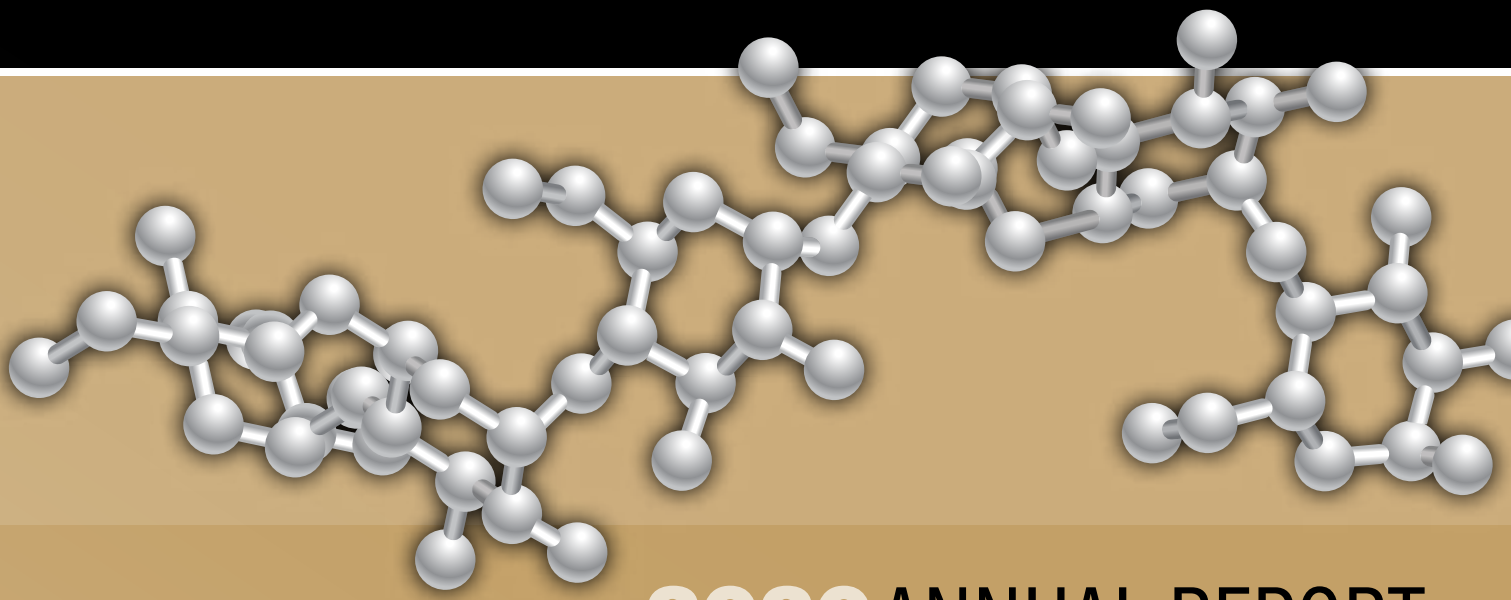
WHISTLER CENTER
for Carbohydrate Research



2020 ANNUAL REPORT

PURDUE UNIVERSITY | Food Science

Industrial Members

(Members of 2020 Industrial Advisory Board)

Archer Daniels Midland

Cargill

General Mills

Grain Processing Corporation

Hayashibara

Kellogg's

Mars Wrigley

Mondelēz International

Nestlé

Novozymes

PepsiCo

Roquette

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YOUNG
BLACK AND
EDUCATED.

Director's Statement

Greetings from the Whistler Center and welcome to our Annual Report. At the time of this writing, we are finally coming out of the Covid-19 pandemic. It's a good time to reflect on what we have been able to do – and not do – in the past year.

Purdue University, as a whole, fared quite well in 2020. A majority of students returned to class in the fall in what turned out to be the largest class in Purdue's history, more than 44,000 undergraduate and graduate students. We are fortunate to have good leadership. Even financially, in this trying time, the university is in good shape. The Whistler Center also fared well, even though our research programs were slowed by the pandemic and we could not have face-to-face meetings with our members.

Over recent years, in addition to our research and analytical service activities, the Center has become more education-focused. Our educative webinars are now conducted six times a year, and audiences for those webinars, as well as our May annual meeting and Technical Conference, October short course, fall meeting and "virtual visits/seminars" have expanded somewhat in the past year. Switching, by necessity, to all-virtual interactions certainly increased attendance at our normal yearly meetings; more people can attend on the web than are able to travel to Purdue. We are open to considering new approaches, such as hybrid meetings, with benefits clearly put for members to actually come to Purdue. Also, certain activities, such as our annual Technical Conference, will be available to non-member guests, and through a low-cost subscription payment for our Education Package.

We now have a small but active group of external Whistler Center faculty members, building our ability to translate science to application. Thanks in particular to Professors Mario Martinez (Aarhus University) and Senay Simsek (North Dakota State University) for contributing popular seminar lectures to our member companies. Big news at the time of this writing is that Professor Simsek will be our new Food Science Department Head at Purdue, starting in July 2021. She brings a wealth of experience in visioning and moving programs to higher levels of excellence, and we look forward to her coming.

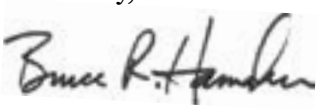
In research, we had our highest number of refereed journal publications ever, with 152 articles published in 2020, distributed over 14 faculty. A number of new grants came in for research in fiber and the gut microbiome, plant-based proteins, and carbohydrates and health. Notably, Mario Martinez was awarded the Young Scientist Research Award from the Cereals & Grains Association for outstanding early-career contributions in cereal science research, and Yuan Yao was promoted to rank of full professor and was awarded the University Faculty Entrepreneurial Scholar Award for his startup company, Phytoption. The Center also initiated a new research program to fund projects of three faculty-industry teams to conduct application-oriented research.

In 2020, we announced a willed gift by Dr. John Fannon, former PhD student of Jim BeMiller, with a match from an anonymous donor, to establish the "Dr. James BeMiller Chair in Carbohydrate Science". We are indebted to John for his generosity and vision to create this important endowed chair for the Whistler Center.

We had sad news of the passing of Dr. Sakharam Patil, who supported us over the years with guidance and friendship as an adjunct professor to the Center (see In Memoriam, page 68). We miss him.

In other matters, we welcomed General Mills, Inc. back as a member of the Center, and see a new interest in food carbohydrate structures and function, particularly in the food and health area, from tech-oriented startups. The carbohydrate landscape is changing, and we at the Whistler Center look forward to continuing to serve the industry and public. Please take a look at our 2020 annual report, and let us know how we can be of assistance to you.

Sincerely,



Bruce R. Hamaker
Distinguished Professor of Food Science
Roy L. Whistler Chair, Director

Summary of Major Research Accomplishments

Starches, Non-starch Polysaccharides and Cereals

J. BeMiller published a second paper of research done with two visiting scientists that supported the hypothesis that differences in the effects of various hydrocolloids (HC) on different starches under different conditions may owe to differences in their effects on the pasting process. Results of the research indicated that the various HC interacted to different degrees with native waxy maize starch granules (controlling their swelling and disintegration). After comparing the results to those for normal maize starch (NMS), it was concluded that most HC acted on both waxy MS (WMS) and NMS, only in different ways and to different degrees, and that the presence or absence of amylose was probably involved in creating the differences, but that that might not be the entire reason. Results also indicated that native WMS, less cross-linked WMS, and more cross-linked WMS each behaved in a distinct way when a HC was added and that most HC effected an increase in granule strengthening with cross-linked NMS being strengthened more than cross-linked WMS.

O. Campanella and **B. Hamaker** finished a project on the formation of pastes and gels formulated with waxy potato starch (WPS) subjected to different shear and temperature conditions, pH, and combination of different hydrocolloids. Unique properties of this WPS were related to its fine structure and tendency to form aggregates by intermolecular double helices. F. Fang was the principal researcher involved in this project and published several articles on the topic, Fang et al. in *Journal of Agricultural and Food Chemistry*, *Carbohydrate Polymers,* and *Food Hydrocolloids*. Work in collaboration with the member company Hayashibara was published focusing on the functional properties of isomaltodextrin, Fang et al., *International Journal of Food Science & Technology*.

M. Martinez' group brings together analytical methods in the fields of foodomics (Projects 22, 23, 24) and food structuring (Project 25), providing breakthrough understanding in the development of sustainable food ingredients, combined with future health-based functionalities. M. Martinez' research group is centered on understanding carbohydrates and associated metabolites. He is also interested in new generation bio-refinery approaches of agricultural and aquatic biomass into biofunctional polymeric streams, mesoscale food and bio-based food packaging (Project 26) structuring, and twin-screw extrusion technologies. The long-term goal of his research is to connect the end of the lines between eukaryotic biomass and human and environmental health, to contribute to a more circular green chemistry, the development of biopolymer circularity, and the prevention/intervention of nutrition-related chronic diseases.

L. Mauer's group leads one of two Center-supported projects on sugar reduction/replacement, taking a materials science approach to manipulate and investigate food ingredient structures and functions, water-solid interactions, and amorphization and crystallization tendencies. Ongoing studies include investigations of the roles of sugars and oligosaccharides on the functional properties of starch (Project 27).

G. Narsimhan's group continued work on fundamental aspects of starch swelling and pasting through a modeling approach and extended it to sugar reduction and replacement (Projects 28, 29).

S. Simsek's group has developed a research program focused on the integration of cereal quality with the structure-function relationships of carbohydrates. The ultimate goal of this group is to increase the utilization of cereal and legume crops and their byproducts while finding new and innovative applications for carbohydrates in the baking industry. Continuing work has determined the ability of cyclodextrins in whole wheat baking applications to mask bitter flavors from phenolic compounds, including spectroscopic and computational characterization of formed complexes (Project 33). Experimental and computational investigations demonstrated that coumaric, caffeic, and trans-ferulic acid in wheat bran extract form inclusion complexes with β-CD by non-covalent bonds. S. Simsek's group has also conducted work on the utilization of hulled wheat (ancient grains) (Project 34). Although hulled wheat species are gaining interest in contemporary food design for their healthier nutritional profile, there is limited literature about the chemical composition and dietary fiber variation of hulled wheats. Findings showed that hulled wheats contained lower insoluble and total dietary fiber contents but higher contents of soluble dietary fiber. Similar shifts in

dietary fiber profile were found in breads prepared from hulled wheat breads. Thus, hulled wheats provide potential health-benefits as prebiotic-enriched food. Finally, S. Simsek's group identified functional contributions of nut byproducts within biodegradable starch-based films (Project 35). Octenyl succinate starch (OSS) films with pecan nutshell extract (PSE) or hazelnut skin extract (HSE) possessed improved resistance to water, improved UV-light blocking properties, and greater plasticity with addition of the extracts. Phenolic compounds from extracts associated with the octenyl succinate starch matrix by hydrogen bonding. Such composite films could be utilized as food packaging films due to the antioxidant and antimicrobial properties of the phenolic compounds.

Y. Yao's group continued work on the characterization of carbohydrate polymers using a molecular rotor (MR) approach (Project 36). His group made progress in exploring MR-related techniques to characterize the performance of biopolymers at oil-water interface, including modified starch, gum arabic, and sodium caseinate, biopolymer concentrations, and oil-to-biopolymer ratios. In other work, he used octenylsuccinate hydroxypropyl phytoglycogen (OHPP) to increase the solubility of niclosamide (Project 37).

Carbohydrates, Nutrition and Health

O. Campanella continued investigation of the nature of gut microbial community interactions through a modelling approach, and a review article is being prepared to be submitted in 2021 (Project 1). Work continued with **B. Hamaker** to investigate the effect of viscosity on the mobility and growth of selected microbiota strains.

B. Hamaker's group furthered their research in the area of dietary fiber prebiotics and targeted function in the gut microbiome, and glycemic carbohydrates and slow digestion property-related activation of the gut-brain axis and ileal brake physiological mechanisms. In 2020, they: 1) continued research on fabricated fiber physical structures and extrusion processing to expand insoluble bran matrices to support beneficial butyrate-producing Clostridia bacteria (Project 4), 2) completed a large *in vitro* fecal fermentation screening of whole food-based fibers from cereals, legumes and pulses, and tubers, showing potentially beneficial effects of these types of dietary fibers on the gut microbiome (Project 5), 3) published a concept paper explaining a new hierarchically-ordered view of dietary fibers based on their chemical and physical complexity, and their resulting function in the gut microbiome (Project 6), and 4) did further work supporting the idea that slowly digestible carbohydrates that digest locationally to the ileum can act as activators of the gut-brain axis for appetite control and weight management (Projects 7 and 8). His group also worked on projects related to grains for processing and zein viscoelasticity (with O. Campanella) (Project 9).

S. Lindemann's research program extended upon its foundations in understanding specific fiber structure-microbiota interactions to developing new theoretical frameworks to predict the ecology of microbial competition for carbohydrates based upon their structure. This year, his lab uncovered that fine differences in carbohydrate structure, either naturally arising or enzymatically modified, governs the diversity and identities of the most efficient microbial fermenters of the fiber (Project 18). Further, recent research related the previously observed particle size effect in fermentation of wheat brans to processing method, in that different means of processing alter how size influences fermentation by microbiota (Project 19). In addition, work in the lab revealed that slight differences in resistant glucan structure selected for specific microbiota across diverse initial donor populations, in ways that suggest that competition among specific microbes is 1) governed by fiber structure and 2) influenced by the community context around them (Project 20). Finally, Dr. Lindemann's group formulated a computational model describing degradation of inulins by microbiota in communities as a function of their chain lengths (Project 21). These advances increase our ability to predict how fiber structures will be metabolized by gut microbial communities, in turn influencing microbiome structure. In addition, S. Lindemann continued work on various fundamental aspects of microbial ecology, which are again represented in many of his publications in 2020.

L. Reddivari's group focuses on harnessing the bioactive compounds in foods to improve gut barrier function and prevent chronic inflammation, which is the underlying cause of many chronic colonic diseases. They are currently working on understanding the role of gut bacteria in the anti-colitic and anti-inflammatory properties of plant flavonoids in the whole food matrix using near-isogenic maize lines and color-fleshed potatoes (Project 31). They are also interested in the interaction between polysaccharides and flavonoids and how the interaction influences the stability and bioavailability of flavonoids and their role in maintaining gut barrier function in health and disease (Project 32).

Other Biomacromolecule Structures

O. Jones' research has determined the effects of fibrous protein structures within polysaccharide-rich media and identified improvements in corn protein function after physical or enzymatic treatment. In a collaborative project with **Drs. Campanella and Hamaker**, fibrous protein structures prepared by either electrospinning or heat-treatment to facilitate spontaneous assembly were incorporated within starch gels or wetted masses (Project 10). The presence of these fibrous protein structures contributed significantly to the elasticity of the gels or masses, although this was highly dependent upon the capacity to distribute these fibrous structures throughout the material and the resistance of those fibrous structures to dissolution/plasticization by water. Extrusion and heat treatments at high temperatures were also utilized to bond corn protein molecules and increase their network strength when dispersed in starch-rich materials. Findings again showed significant yet temporary improvements in elasticity and strain-hardening properties. As an alternative approach to improve corn protein function, the protein was modified by enzymatic hydrolysis and conjugation with short polyglucosamine chains (Project 11). Findings showed significant improvement in water solubility, emulsification, and foaming capabilities.

J. Kokini's group studies rheological and networking behavior of biopolymers, nanocomposites, their fabrication and properties, and new methods of detection of discrete components in complex food materials. In 2020, they were active in many research areas: 1) molecular origins of how pea protein forms gels and emulsions (Project 12), the relationship between the nonlinear behavior of soft, hard, and semolina dough by using medium amplitude oscillatory shear (MAOS) measurement and cream cheese by LAOS measurement (Projects 13 and 15), development of a process for low temperature functionalization of pea protein involving sub-zero temperatures (Projects 14), creation of a SERS biosensor platform based on electrospun nanofibers from soy protein isolate (SPI) to detect analytes in food (Project 16), and evaluation of the efficacy of pectin-chitosan and gelatin-chitosan-based food coatings on the quality and post-harvest preservation of fruits and vegetables (Project 17).

Chemical Structure and Functions of Polysaccharides

B. Reuhs and A. Terekhov run the analytical core facility at the Whistler Center dedicated to complex carbohydrate structural analysis. With **O. Campanella**, **B. Hamaker**, and **S. Lindemann** the group provides expertise and studies on non-starch polysaccharide structures and their physicochemical and rheology functionality and gut microbiota fermentation**.**

The **O. Campanella, O. Jones,** and **B. Reuhs** group has focused to understand the role of polysaccharides in structure-function relations in various biological and food systems. Specifically, the group has completed work dealing with the structure and functionality of polysaccharides (e.g., pectins) in processed foods, such as tomato products. Ultrasound technology is recognized as a potential non-thermal technique to improve the quality of food products. It was demonstrated that ultrasound can be used as a potentially alternative to process tomato or other plant-based products. Future work is focusing on the physical properties of the particles in relation to the rheology of these products.

Emerging Food Processes

O. Campanella's group finished work on the processing of foods with the aim of optimizing conditions to achieve good quality and safe foods. Thermal and non-thermal processes were studied. Thermal processing of foods involved the use of microwave, whereas non-thermal processes involved research on cold plasma processing and pulsed electric field. The group studied inactivation parameters of spore cells using the non-thermal pulsed electric field (PEF) treatment (Project 2), and an innovative green clean-in-place technology for processing environments using nano and microbubbles. The developed model enabled the calculation of the microbial inactivation rate as a function of several key processing parameters that enabled to define a unique threshold condition to meet the food safety requirements for products processed with the PEF technology. Current work is focusing in using ozone micro and nanobubbles for surface disinfection (Project 3).

Staff Directory

Faculty

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Akiva Gross	Adjunct Professor
Bernhard Van Lengerich	Adjunct Professor

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Nana Wu	Hamaker	January 2020-January 2021

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Faculty

James N. BeMiller

General Research Areas

- Starch
- Carbohydrate chemistry

Specific Research Areas

- Starch granule structure, reactivity, and behavior
- Chemical and biological modifications of starch
- Structure-functional property relationships of polysaccharides

Osvaldo H. Campanella

General Research Areas

- Process modeling
- Rheology
- Material structure and texture
- Extrusion

Specific Research Areas

- Application of rheology to food science and food engineering
- Mathematical modeling of food process operations
- Online rheological techniques
- Rheology of biomaterials
- Dough rheology
- Rheology of dairy products
- Characterization of material structure and texture; relationship to rheological properties
- Effect of glass transition on product texture
- Bioplastics: Uses of food processing wastes
- Reactive extrusion in the production of foods and bioplastics

R. Chandrasekaran

General Research Areas

- X-ray diffraction
- Molecular architecture of biopolymers

Specific Research Areas

- Starch crystallinity
- Conformation of carbohydrates and nucleic acids
- Structure-function relationships in polysaccharides and polysaccharide mixtures

Mario G. Ferruzzi

General Research Areas

- Development of methods for determination of micronutrients and phytochemicals (carotenoids and phenolics) in complex food and biological matrices
- Characterization of food matrix factors that optimize stability and bioaccessibility of micronutrients and phytochemicals
- Exploration of genetic, food matrix and ingestive factors that impact bioavailability and metabolism of phytochemicals from plant foods using preclinical and clinical models

Bruce R. Hamaker

General Research Areas

- Carbohydrates and health
- Starch, chemistry and function
- Dietary fiber, chemistry and function

Specific Research Areas

- Glycemic carbohydrate digestion for slow digestion/low glycemic response, physiological response
- Dietary fiber, modifications in functionality and gut fermentability, gut microbiota and metabolites
- *In vitro, in vivo*, cell culture studies
- Cereal carbohydrate and protein functionality
- Textural properties influenced by carbohydrates
- Interactions between carbohydrates and other food components
- Appropriate methods of improving cereal utilization in developing countries

Owen G. Jones

General Research Areas

- Energy and stoichiometry of polysaccharide interactions with other materials
- Determination of size, morphology, and stability of colloidal suspensions
- Atomic force techniques to determine morphology and elasticity of sub-millimeter material

Specific Research Areas

- Role of chemical and physical structures in defining protein-polysaccharide interactions
- Controlled assembly of fibrous or particulate colloids from polysaccharides or proteins
- Emulsifying properties of colloidal materials
- Contributions of colloidal polysaccharide/protein assemblies to films, gels, or pastes

Jozef Kokini

General Research Areas

- Food materials science
- Linear and non-linear rheology
- Computational fluid dynamics
- Food nanotechnology and fabrication of nano-biosensors
- Phase behavior and compatibility of ingredients in food mixtures
- Food structure and texture during extrusion, mixing processes and computational fluid dynamics

Stephen Lindemann

General Research Areas

- Dietary fiber impacts on gut microbiome diversity, structure, and function
- Species-resolved metagenomics and metabolism
- Genomic mechanisms of polysaccharide fermentation
- Carbon, nitrogen and energy cycling by gut microbiota
- Microbiome-mediated impacts on host physiology

Specific Research Areas

- Particle size and processing method impacts on microbial metabolism of wheat bran
- Arabinoxylan structure influences on gut microbiome structure and function
- Predictive ecology of gut carbohydrate metabolism
- Fiber targeting to gut microbes

Mario Martinez

General Research Areas

- Carbohydrate chemistry
- Cell walls and associated metabolites
- Food structuring

Specific Research Areas

- Structural elucidation of polysaccharides
- Structure-function-digestion relationships or carbohydrate foods
- Food and agricultural waste valorization through technology development
- Phenolic-carbohydrate interactions during food processing
- Structuring of plant-based meat analogues

Lisa J. Mauer

General Research Areas

- Food chemistry
- Water-solid interactions
- Food materials science

Specific Research Areas

- Structure-function relationships of food ingredients
- Solid state characterization
- Glass transitions
- Moisture sorption
- Deliquescence
- Crystallization and amorphization

Ganesan Narsimhan

General Research Areas

- Emulsions and foams
- Biopolymer interactions

Specific Research Areas

- Pore formation by antimicrobial peptides in cell membranes and lipid bilayers
- Pasting behavior of starch
- Stability and texture of food emulsions and foams
- Adsorption of proteins and protein-polysaccharide complexes at interfaces
- Functional properties of proteins and protein-polysaccharide complexes
- Physical and chemical modification of proteins for use as food stabilizers
- Rheology of polysaccharide solutions and gels

Lavanya Reddivari

General Research Areas

- Plant bioactive compounds and health
- Flavonoids and carotenoids
- Gut microbial metabolism

Specific Research Areas

- Anti-inflammatory plant bioactives for improved gut health
- Reciprocal interaction of gut microbiome and plant bioactives in health and disease
- Interactions between plant bioactives and fiber/starch in the modulation of gut bacteria

Bradley L. Reuhs

General Research Areas

- Polysaccharide analysis
- Bacterial and plant cell wall compositions, structures and functions
- Sugars and polysaccharides in nutrition and food systems

Specific Research Areas

- Extractions and purification of acidic polysaccharides from cell walls of plants (including food products) and bacteria
- Pectin, hemicellulose, capsule, gum and lipopolysaccharides analysis
- Application of HPLC, MS, GC, GC-MS, FT-IR and NMR to structural studies of carbohydrates, including polysaccharides

Senay Simsek

General Research Areas

- Structure-function relationships of carbohydrates
- Cereal and legume quality
- Utilization of cereal crops
- Application of carbohydrate ingredients in the baking industry

Specific Research Areas

- New carbohydrate functional ingredients
- Innovative uses for processing by-products and waste materials
- Biodegradable packaging films

Clifford F. Weil

General Research Areas

- Plant classical and molecular genetics
- Protein structure and function
- Gene expression
- Large-scale forward and reverse genetics screening
- Genome maintenance and organization
- Genomics of starch digestion, composition and architecture

Specific Research Areas

- Rational redesign of corn starch composition
- Computer modeling of starch synthases
- Mutational analysis of starch biosynthesis in corn and *E. coli*
- Genetic modification of corn starch properties

Yuan Yao

General Research Areas

- Novel biomaterials for food and health
- Chemistry and genetics of carbohydrate polymers
- Nanotechnology for foods and drugs
- Coating of active ingredients

Specific Research Areas

- Construction and characterization of nano-biomaterials
- Stabilization, solubilization and delivery of active ingredients
- Genetic, enzymatic and chemical modifications of starch
- Functional food ingredients
- Carbohydrate microanalysis
- Evaluation and removal of pathogen biofilms
- Roll-to-roll coating of active ingredients

Adjunct Faculty

Yonas Gizaw, PhD, is principal scientist at The Procter and Gamble Co. Currently, he is technical leader for Chemistry Transformative Platform Technologies in Corporate R&D. Dr. Gizaw is a 20-year veteran of P&G with broad experience in biopolymers, nanotechnology, polymers physical chemistry, surfactants and colloids. He spent about eight years in Snack and Beverages, where he supported technology development for beverages (Sunny D) and Snacks (Pringles), then moved to the Fabric Care Strategic and Innovation division, where he was responsible for development of strategic technologies for cleaning and fabric feel (Downy & Tide), etc. The last several years Dr. Gizaw has focused his research on physical chemistry of wetting phenomena to develop disruptive technologies in Superhydrophobic and Superomniphobic surfaces. Prior to joining P&G, Dr. Gizaw received his doctoral degree from Purdue University in synthetic carbohydrate chemistry.

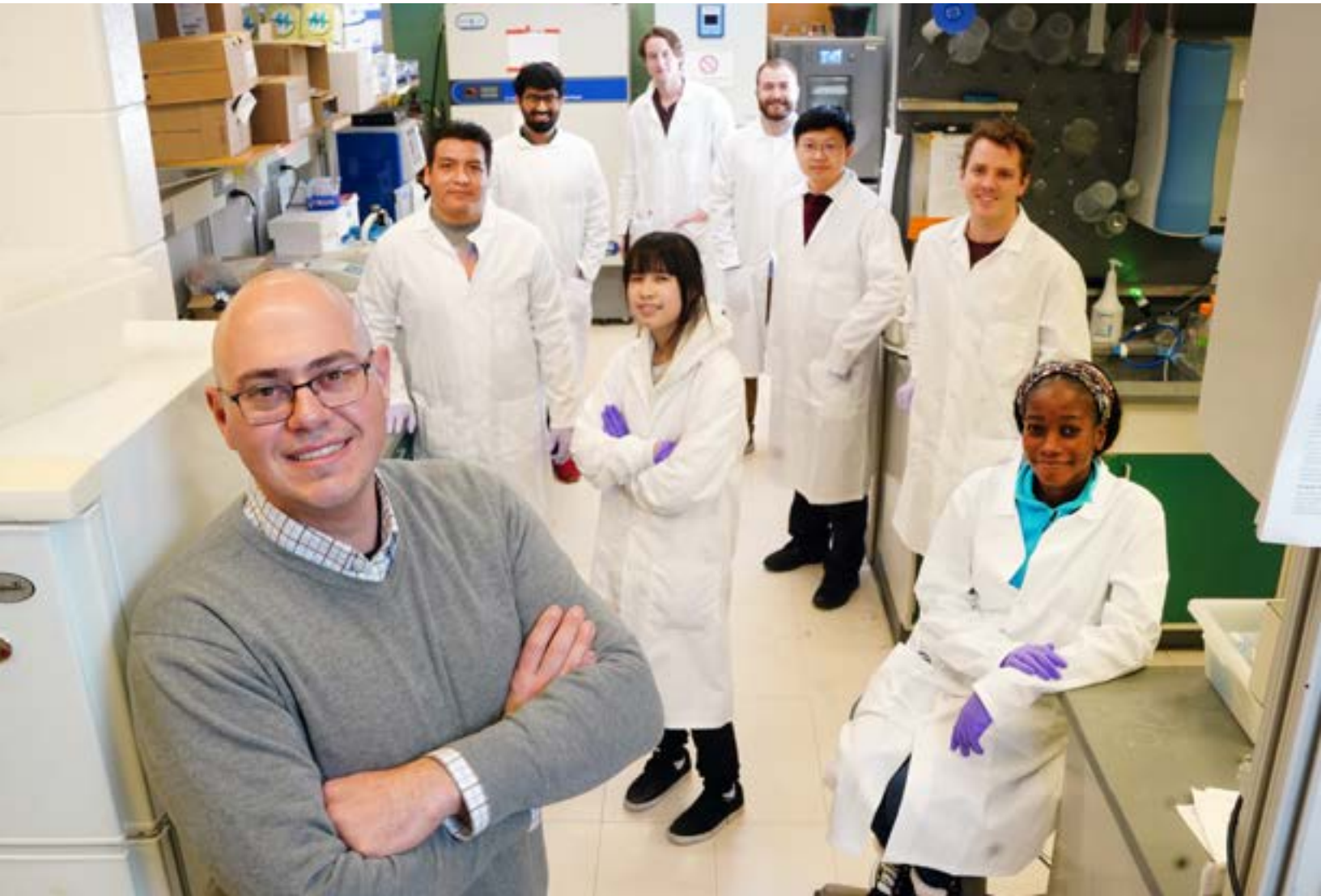
Akiva Gross, PhD, is president of A.T. Gross Consulting, Ltd. Dr. Gross received his doctoral degree in Organic Chemistry from the Weizmann Institute of Science in Israel and then continued his scientific training in Applied Enzymology in the chemistry departments of Massachusetts Institute of Technology and Harvard University. Before starting his consulting business, Dr. Gross served as a vice president of Global Product Development at Corn Products International. Prior to joining the company, Dr. Gross held several R&D leadership positions at CP Kelco and Monsanto. He was also a co-founder, senior vice president of R&D and a member of the Board of Directors of Opta Food Ingredients, Inc. Opta Food Ingredients was established as a spinoff of Enzytech, Inc., where Dr. Gross was a co-founder and vice president of R&D.

Bernhard Van Lengerich, PhD, former CSO and vice president of Technology Strategy at General Mills, Inc. After more than 20 years of service, Bernhard retired from General Mills in March 2015. He is a strategic advisor and serves as a board member of several companies and nonprofit organizations. He is founder of the Seeding the Future Foundation, Past Chair of Feeding Tomorrow (IFT's nonprofit organization) as well as Vice Chair of Bountifield International (formerly Compatible Technology International), a nonprofit organization in Minnesota, focusing on post-harvest loss reduction in sub-Saharan Africa. Bernhard completed his PhD in Food/Biotechnology at the Technical University of Berlin, Germany. His work experience includes Unilever Germany; RJR Nabisco, New Jersey; and Buehler AG in Switzerland. In 1994, Bernhard joined General Mills, Inc., in Minneapolis. He led the development of numerous technologies and capabilities resulting in major product innovations. Bernhard authored/co-authored more than 100 patents, established and led a Game Changer program, and created a novel "Cashless Venturing" initiative, enabling faster and more disruptive innovations.

Visiting Professors

Haitao Wu completed her BS and MS degrees in Food Science from Dalian Polytechnic University in July 2002 and July 2005, respectively. She obtained her PhD degree from the Graduate School of Natural Science and Technology of Okayama University in September 2008. Now she is a professor in the School of Food Science of Dalian Polytechnic University. She joined Dr. Jozef Kokini's group as a visiting professor in September 2019. Her research focuses on the rheological and physiochemical properties of protein hydrolysates from scallop. She continued her research in Kokini's lab until August 2020. She works at Dalian Polytechnic University.

Nana Wu completed her BS and MS degrees in Food Science from Henan University of Technology in 2005 and 2008, respectively. She obtained her PhD degree from South China University of Technology in 2012. Now she is an associate professor in Academy of National Food and Strategic Reserves Administration in China. She joined Dr. Bruce Hamaker's group as a visiting professor from January 2020 to January 2021. Her research focused on the dietary fiber chemical and structural analysis and effect on the human gut microbiota.



Visiting Scientists

Isaac Kwabena Asare started his undergraduate education in the University of Cape Coast, Ghana, where he earned a BSc in Entomology. He continued in a master's program in radiation processing at the University of Ghana. He is currently working on his PhD at the University of Pretoria, South Africa. He came to Purdue University as a visiting scientist at the Whistler Center in Dr. Bruce Hamaker's lab on the topic of starch-lipid inclusions and their *in vitro* gut fermentation. He arrived in February 2019 and returned to South Africa in December 2020.

Enrique Bográn Larach started his undergraduate education at Zamorano University, Honduras, receiving a BS in Food Science. He had the opportunity to participate as a visiting scholar in Dr. Lavanya Reddivari's group in 2020. He work was on metabolomic profiles based on serum samples that included 3-deoxyflavonoids and 3-hydroxyflavonoids to determine their anti-inflammatory properties.

Neslihan Bozdogan earned her BS from the Department of Food Engineering of Hacettepe University in 2011 in Turkey. She completed her MS in the Department of Food Engineering at Ege University in 2015 in Turkey and began her PhD in the same department. After receiving the TUBITAK scholarship, she joined Dr. Jozef Kokini's group as a visiting scientist in June 2018. Her research focuses on the determination of extensional flows and maximum stable bubble size distribution inside a model batch mixer during the mixing of hard wheat flour dough using numerical simulation. She continued her research in the Whistler Center until January 2020. She is expected to graduate in May 2021.

Zhuoran Chen received her BS from the Department of Food Science at Purdue University in May 2020. She joined Dr. Yuan Yao's lab in fall 2020 to work on phytoglycogen derivatives. She is seeking an MS opportunity in the field of food science.

Henry Cocón visited the Stephen Lindemann laboratory on internship from Zamorano Pan-American Agricultural School from January to April 2020. During his visiting scholarship, Henry assisted with experiments to characterize resistant glucan structures and microbial community responses to variant structures. These experiments were unfortunately cut short by the pandemic-driven research shutdown, and Henry finished his time in the laboratory assisting with genome reconstruction from metagenomes.

Wanying He is a visiting Food Science PhD student from Huazhong Agricultural University in China. Her dissertation is on the structure and modification of corn protein, including zein. Wanying received funding from the China Scholarship Council to study at Purdue University in the laboratory of Dr. Owen G. Jones for two years. She began her studies at Purdue in August 2019 and has been identifying techniques to improve zein functionality by chemical and enzymatic treatments, including interactions with polysaccharides.

Yusong Jin was a visiting scientist from Northeast Forestry University in China. Her research is mainly focused on investigating new technologies for efficient multistage utilization of lingonberry and its bioactive flavonoids. She works in Dr. Lavanya Reddivari's laboratory.

Oluwatoyin Sangokunle received his BS in Food Science and Technology from the Federal University of Technology Akure (Ondo, Nigeria) in April 2015 and earned an MS in Agricultural Science at Florida A&M University in 2017. He joined Dr. Bruce Hamaker's lab as a visiting scholar in 2019 to conduct research related to his dissertation at Florida State University. His doctoral research focus is on relation of pulse starch structure to digestibility and fermentability in an in-vitro system. His work will facilitate the potential application of pulse starch as an alternative, clean, healthy, prebiotic, and gluten-free food ingredient. His anticipated graduation date is summer 2021.

Xiangquan Zeng received his BS from the College of Biological Sciences and Technology in Beijing Forestry University in 2015. Then he went to China Agricultural University to pursue his M.S. and Ph.D. studies in Processing and Storage of Agriculture Products. His research topic was characterization and functional properties of condensed tannins from green-mature bananas. He joined Dr. Jozef Kokini's group as a visiting scientist in November 2019. His research focuses on the fabrication of effective delivery systems for banana condensed tannins. He continued his research until December 6, 2020.

Graduate Students

Miguel Alvarez Gonzales completed his BS in Food Science and Technology at PanAmerican Agricultural School, Zamorano University. Previously, he worked on designing bioactive packaging materials for roll-to-roll manufacturing. In the Whistler Center, he worked under the advisement of Dr. Yuan Yao on a rapid screening test for breeding lines related to starch quality and the characterization of carbohydrate polymers, and graduated with his MS in summer 2019. He now is studying toward his PhD with Dr. Stephen Lindemann on the topic of cereal fibers and the gut microbiome.

Emmanuel Ayua graduated from Moi University in December 2011 and earned a MSc in Community Nutrition from the University of Eldoret. He joined Dr. Bruce Hamaker's lab in 2016 and has worked on effect of extrusion on the fermentation of dietary fibers and extrusion processing of cereals in developing countries. Emmanuel will complete his PhD in Food Science in 2021 and return to Kenya as a faculty member of University of Eldoret.

José Bonilla earned his BS in December 2014 from the Food Science and Technology Department at Zamorano University in Honduras. During spring 2014, he worked as a visiting scholar in Dr. Yuan Yao's lab, using polysaccharides from starch to improve thymol solubility. In January 2015, he began studies for his doctorate degree in Dr. Josef Kokini's lab. His PhD research focused on the use of inorganic fluorescent nano-probes (quantum dots) as an *in situ* labeling technique to study the distribution and rheological properties of cereal proteins. José completed his PhD in Food Science at Purdue University in 2020.

Subhadeep Bose received his bachelor's degree in Food Technology and Biochemical Engineering from Jadavpur University, India, in April 2019 and joined Purdue in August 2019 for his MS in Food Science. He is currently co-advised by Dr. Owen Jones and Dr. Ganesan Narsimhan. His research primarily focuses on oligosaccharide impacts on starch swelling behavior and is part of the Whistler Center's project on sugar reduction/replacement.

Nathaniel Brown received his BS in Biological and Agricultural Engineering with a minor in Food Science from Kansas State University in May 2018. He had various internships with companies like Bimbo Bakeries USA as a process engineer (2016) and McCormick & Company in technical innovation (summer, 2017 & 2018). He joined Dr. Osvaldo Campanella's lab in August 2018 and completed his ABE MS in May 2020, conducting research on the interactions between rheology and interface science with microbubbles and applications in cleaning and sanitization. He now works as an innovation scientist for AFB International.

Nuseybe Bulut completed her BS degree in July 2014 at the Food Engineering Department, Istanbul Technical University (ITU), Turkey. She joined Dr. Bruce Hamaker's lab group in January 2017. Her MS research focused on fabrication of plant cell wall-like materials and their impact on the human gut microbiota, and she graduated in fall 2019. She continues her PhD studies with Dr. Hamaker in the area of dietary fiber and the gut microbiome.

Jingfan Chen received her BS in Food Science from Purdue University in 2015. She joined Dr. Yuan Yao's lab in 2016 to pursue her PhD. Her main research focus has been on phytoglycogen and its derivatives for food and pharmaceutical uses. She has also studied the use of a molecular rotor for biopolymer characterization. She is working toward her PhD with an anticipated graduation date of May 2021.

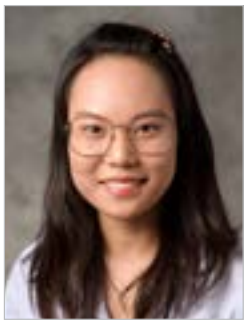
Dennis Cladis earned his BA in Chemistry and Mathematics from DePauw University in 2009. He earned his MS in synthetic inorganic chemistry at Purdue in 2012. He discovered a passion for food science as a practical application of his chemistry and subsequently earned his MS in Food Science at Purdue in 2014, with his research focusing on fatty acid profiles and mercury content in fish. He completed his PhD in Food Science at Purdue in spring 2019 under the direction of Drs. Mario Ferruzzi and Connie Weaver investigating polyphenol toxicity and changes in metabolism that occur with increased doses of blueberry polyphenols.

Sarah Corwin, RD, completed her PhD in Food Science at Purdue University in 2020. She is currently principal scientist for MGP Ingredients, Inc. in Atchison, Kansas. She also acts as a clinical dietitian on a consulting basis. As a graduate research assistant at Purdue, her studies focused on structure-function relationships, rheology, and application of novel slow-digesting carbohydrates. She is an active volunteer in numerous professional organizations, including the American Society of Baking (ASB), Institute of Food Technologists (IFT) Carbohydrate Division, and the Cereals and Grains Association. Additionally, she was a member of the Purdue Hoosier Chapter of the food science honor society Phi Tau Sigma. Under her leadership as president in 2019-2020, the chapter received Outstanding Chapter of the Year 2020.

Gnana Prasuna Desam earned her B. Tech. degree in the Department of Agricultural and Food Engineering from Indian Institute of Technology, Kharagpur, in July 2014. She joined Dr. Ganesan Narsimhan's group in June 2015 to pursue a PhD and worked on prediction of swelling kinetics of waxy cornstarch and modified waxy cornstarch. Prasuna received her PhD from the Department of Agricultural and Biological Engineering in May 2020.

Jayani Maddakandage Dona completed her BS degree in Food Science and Nutrition from the Department of Food Science and Technology at Wayamba University of Sri Lanka in 2017. At North Dakota State University, she worked under the advisement of Dr. Senay Simsek on nutritional quality of ancient wheat species and graduated with her MS in summer 2020. She continues her studies toward her PhD with Dr. Simsek. Her research focuses on dietary fiber and gut microbiome.

Enrico Federici earned his BS degree in Food Science and Technology in July 2014 from University of Parma. During work there on his master's, he joined Dr. Osvaldo Campanella's lab as a visiting scholar for six months, working on a collaborative research project between Purdue University and the University of Parma. This contributed to the completion and defense of his MS thesis in October 2016. Enrico joined Drs. Owen Jones and Campanella's labs in August 2017 as a PhD student. His research has focused on improvement of gluten-free products with the use of novel protein preparations and assemblies. Enrico plans to complete his PhD in spring 2021, and will join the Beyond Meat Co.



Wenyi Fu received her BS degree from the Department of Food Science at Purdue University in 2019. She then joined Dr. Lavanya Reddivari's lab group to pursue her MS. Her area of interest is food chemistry, and her current research focuses on how dietary fibers and polyphenols affect the human gut microbiota and gut health.

Anna Hayes received her BS in Food and Nutrition Science and her BA in Spanish from Saint Catherine University (Saint Paul, Minnesota) in May 2014. Anna joined Dr. Bruce Hamaker's lab as a direct bachelor's-to-PhD student in the Purdue Food Science Department in August 2014. Her research has focused on investigating the slow digestion and satiety properties of pearl millet grown in sub-Saharan Africa, the metabolic consequences of carbohydrates with differing digestion rates, and the implications of starch fine structural features on digestibility and texture applications through collaborative projects. Ultimately, her work will help identify characteristics of glycemic carbohydrates that impart a slow digestion property and elucidate how they can be leveraged to design foods with targeted physiological and metabolic outcomes. She will complete her PhD in spring 2021 and join a group at University of Southern California as a postdoc to study diet and appetite control.

Harrison Helmick is a master's student in the Department of Food Science at Purdue University under the guidance of Dr. Jozef Kokini. His research focuses on how yeast metabolites impact wheat dough rheology. Harrison studied at Kansas State University and obtained a degree in Bakery Science. This turned into a career at Bimbo Bakeries, where he worked in production and process improvement. He hopes to continue to blend lean Six Sigma practices with the fundamentals of food science in order to advance the world of cereal science.

Enosh Kazem received his BS in Food Science from Purdue University in 2011. After graduation, he spent two years in medical school at Indiana University, then began studying in Dr. Bruce Hamaker's group. Enosh graduated with his MS in Food Science in December 2020, having investigated whole food prebiotics in grains, tubers, and pulses.

Ana Magallanes López completed her BS in Agroindustrial Engineering in fall 2015 at Chapingo Autonomous University in Mexico. Then she worked as a research assistant in the Wheat Quality and Chemistry Laboratory at the International Maize and Wheat Improvement Center (CIMMYT). In spring 2017, she joined Dr. Senay Simsek's lab at North Dakota State University to pursue graduate studies. She worked on the fate of deoxynivalenol during wheat wet-milling and characterization of the DON-free extracted starch and gluten, and she graduated with her MS in fall 2018. In spring 2019, she started her PhD, continuing under the advisement of Dr. Simsek at North Dakota State. She is currently working on extracting soluble dietary fiber from dry beans to study how its composition interacts with the immune system during a chronic condition, such as obesity.

Mehdi Marashi received two MS degrees in Civil Engineering from University of Tehran and Purdue University before joining Dr. Stephen Lindemann's research group in 2020. His research focus was on numerical modeling of nonlinear and stochastic systems, and now he is working on modeling the ecology of microbial competition for varying oligosaccharide structures.

Cindy Mayorga completed her BS degree in Food Engineering at Universidad Tecnologica de Panama in 2016. She worked as a research assistant during her bachelor's thesis at the same university before coming to Purdue University. In 2019, she received a Fulbright scholarship to join Dr. Jozef Kokini's lab to pursue her MS and work on the development of biosensors.

Mai Lea Nguyen received her BS in Microbiology and Food Safety at the University of Arizona. Previously, she worked on antibiotic resistance prevalence in alternative water sources, the efficiency of eco-friendly cleaners on household surfaces against foodborne pathogens, and isolating Cyclospora cayetanensis oocysts from influent and effluent water. Joining Purdue in fall 2020, Mai is pursuing a MS in Food Science under the mentorship of Dr. Stephen Lindemann. Her research focuses on the effect of resistant dextrins on the consortia evolution of the gut microbiota.

Adrianna Pilch received dual BS degrees in Food Science & Human Nutrition and Chemistry at the University of Illinois at Urbana-Champaign in May 2020. She joined Dr. Lisa Mauer's lab in August 2020 to pursue her MS in Food Science. Adrianna is currently researching the effects of ascorbic acid on wheat starch gelatinization.

Sarah Pitts received her BS in Biochemistry from Purdue University in 2019. She joined Dr. Lisa Mauer's lab group in 2019 to pursue a MS in Food Science. Sarah's current research focuses on sensory analysis of bakery products formulated with oligosaccharides.

Adam Quinn completed his BS in Food Industry Management from the Department of Food Science at Brigham Young University and went on to finish his MS in Food Science in the same department. The focus of his graduate research was pathogens in low-moisture foods and an international development project in Mongolia on post-harvest technologies for vegetables. He joined Dr. Stephen Lindemann's lab in fall 2020 to begin a PhD. Adam's research is centered on the impact of wheat fiber on the gut microbiome.

Monica Richmond received two bachelor's degrees from North Carolina State University in Food Science and Bioprocessing Science with a minor in Biomanufacturing in December 2019. Following graduation, Monica continued her work on texture retention of fermented and acidified vegetables as a research lab technician. She then joined Dr. Bruce Hamaker's lab group to pursue her master's, focusing on the effects of viscosity on the gut microbiome with regard to the utilization of dietary fibers.

Arianna Romero Marcia received her BS in Food Science and Technology from Zamorano University, Honduras. She joined Dr. Stephen Lindemann's lab in 2018 to pursue her MS in Food Science. Her interests has focused on dietary fiber and the interaction with the gut microbiota. She also had R&D industry experience connecting the microbiome sciences with product development. Her work relates to how glucans chemical structure modulates the human gut microbiome structure and function.

Felicia Aba Sackey has a BSc in Biochemistry, Cell and Molecular Biology from the University of Ghana, Legon. She is currently a Pulse (Purdue Interdisciplinary Life Sciences) student working under the supervision of Dr. Stephen Lindemann. Her graduate study is on the evolution and mechanism of the usage of multiple variably sized fructooligosaccharides in a wild human *Escherichia coli* strain.

Jacob Thompson earned his bachelor's in Materials Science and Engineering from Michigan Technological University in May 2019. However, he soon discovered a passion for nutrition and decided to pursue it in the Interdepartmental Nutrition Program at Purdue. He joined the Lindemann lab in fall 2020 and is focusing on developing a coculture system between intestinal cell lines and gut flora. The goal of the research is to learn how cells and bacteria interact, as well as understand how carbohydrate structure influences the ecology of the gut microbiome.

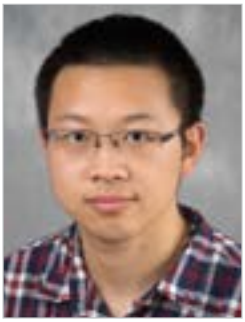
Pablo Torres-Aguilar received his MS in Nutritional Sciences from the University of Illinois at Urbana-Champaign and completed his dietetic internship at Beaumont Health System in Royal Oak, Michigan. At Illinois, he worked with Dr. Juan Andrade, examining the effect of potential fortification strategies for iron delivery in Guatemala, and subsequently with Dr. Angela Wiley, assessing food insecurity and the impact of environmental factors on the diet patterns of Latinos in the U.S. He joined Dr. Bruce Hamaker's group in fall 2014 and is working toward completing his PhD in the area of slowly digestible carbohydrates, postprandial glycemic control, and metabolic flexibility, with an anticipated graduation date of August 2021.

Hazal Turasan completed her BS in Food Engineering at Middle East Technical University in 2011 in Turkey. She completed her MS in the same department. After receiving a Fulbright scholarship in 2014, she joined Dr. Josef Kokini's group for her PhD studies. She worked on fabricating biodegradable biosensor platform using corn protein to detect food toxins and allergens. She recently earned her PhD in 2020 and is currently working as a postdoctoral researcher in Biomedical Engineering at Purdue.

Adrienne Voelker graduated from the University of Notre Dame in 2016 with a BS in Chemistry. She joined Dr. Lisa Mauer's lab group in 2016 to pursue her MS in Food Science and has since received approval to bypass to the PhD program. Adrienne's current research focuses on improving thiamine delivery in foods by studying its physical and chemical stability in its amorphous form in different formulations, and she has taken a leading role in a project exploring the use of sucrose crystallization inhibitors. Adrienne completed her PhD in December 2020 and is working as a research scientist in the Materials and Process Technology department at McCormick & Company.

Travis Woodbury is a PhD student in Dr. Lisa Mauer's lab, currently working on developing sugar reduction strategies in baked good systems. Specifically, his research involves examining how the physicochemical properties of different non-digestible oligosaccharides and other sugars influence the thermal properties of wheat starch, namely gelatinization, pasting, and retrogradation. His work on the effects of commercially available sucrose replacers on wheat starch and cookie texture properties was recently published in the Journal of Food Science and was the cover page for the 2021 March edition. He has also published, in the Manufacturing Confectioner, on the functionality of non-digestible oligosaccharides as added sugar replacements in confections and chocolate. In 2018, he obtained a BS in Food Science from Brigham Young University-Idaho, where he worked as a lab assistant for Dr. Kerry Huber, a Purdue and Whistler Center alumnus.

Binning Wu received her BS in Agronomy from China Agricultural University in 2016. She started her PhD study in the plant biology program at The Pennsylvania State University in August 2016. She joined Dr. Lavanya Reddivari's lab as a graduate student in fall 2017 and moved to Purdue to continue her doctoral studies under Dr. Reddivari. Her research focuses on the anti-inflammatory properties of maize 3-deoxyflavonoids and 3-hydroxyflavonoids against ulcerative colitis.



Tianming Yao obtained his BS in Food Science and Technology from Shanghai Jiao Tong University, China. His undergraduate research was on the OSA modification of small granule starches. He joined Dr. Srinivas Janaswamy's group in August 2015 as a Master's student with support from China Scholarship Council. His research focused on the interaction between polyphenols and starches. Tianming is now a PhD student with Drs. Stephen Lindemann and Bruce Hamaker and works on dietary fiber and the gut microbiome.

Merve Yildirim received her BS in Food Engineering from Middle East Technical University in 2013 in Turkey. She completed her MS in the same department, focusing on low-fat products with double emulsions. She joined Dr. Jozef Kokini's laboratory for her PhD studies in 2017. Her research focuses on nonlinear rheological properties of biopolymers.

PhD Postdoctoral Research Associates

Matthew Allan received a BS in Food Science from Washington State University in 2012 and received a MS (2014) and a PhD (2018) in Food Science from Purdue University under Dr. Lisa Mauer. His graduate research focused on deliquescence, developing crystal hydrate phase diagrams, and investigating the effects of sugars on gelatinization. He was the recipient of the James and Pari BeMiller Graduate Scholarship. Matthew was a postdoctoral research associate in 2019 in Dr. Mauer's lab, funded by a NIFA grant to research the effects of sugars and salts on starch retrogradation. In 2020, Matthew accepted a research associate position in the Food Science and Market Quality and Handling Research Unit at USDA-ARS.

Thaisa Cantu-Jungles received her BS in Nutrition from the Pontificia Universidade Católica do Paraná (Brazil). She earned her MS and PhD in Biochemistry at Federal University of Paraná (Brazil). In 2015, she joined Dr. Bruce Hamaker's group as a visiting scholar for a year to conduct part of her PhD research. In 2018, she rejoined Dr. Hamaker's group as a postdoctoral researcher in the area of dietary fiber fermentation by the gut microbiota. Her research focuses on specificity of structure of dietary fibers and microbiota response.

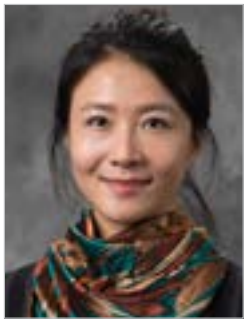
Da Chen received his doctorate from the University of Auckland and joined Dr. Owen Jones's lab in March 2019 as a postdoctoral researcher. In March 2020, he joined Dr. Osvaldo Campanella's laboratory at The Ohio State University. He studies microstructure, water migration, and rheology of protein structures in suspensions or composites. This has included studies on protein nanofibrils within electrospun fibers or starch gels and vegetable protein aggregates in gels. His work with the Whistler Center for Carbohydrate Research has been published in *Carbohydrate Polymers* and *Biomacromolecules*.

Hawi Debelo earned her BA in Biochemistry from Manhattanville College, New York, in 2012. Following her undergraduate career, Hawi worked at PepsiCo Global Research and Development Center as a product development technician. She spent two years at PepsiCo, conducting research with product developers in innovation, formulation, and commercialization of Pepsi products. Hawi joined Dr. Mario Ferruzzi's lab in 2014 as a PhD student. She worked on a project to evaluate the stability, bioaccessibility and bioavailability of bioactive compounds from native African plant materials, and completed her degree in 2018 at Purdue University. Hawi then took a position as a postdoctoral researcher for Dr. Ferruzzi at North Carolina State University and is now working at International Flavors & Fragrances, Inc.

Marwa El Hindawy, from Cairo, Egypt, received her PhD from Purdue University in December 2018. She worked with Dr. Bruce Hamaker on slowly digestible carbohydrates and their role in activating the gut-brain axis for satiety through the enteroendocrine L-cells. Her work showed the potential for ileal-digesting slowly digestible carbohydrates to be used in weight management. She is now a postdoctoral research associate in Dr. Hamaker's laboratory.

Fang Fang received her PhD from Purdue University in 2017, co-supervised by Drs. Osvaldo Campanella and Bruce Hamaker on shear-induced intermolecular associations of amylopectin. She rejoined Dr. Hamaker's group from 2018 to 2020 as a postdoctoral research associate and worked on industrial projects related to the fabrication and application of dietary fibers.

Oguz Kaan Ozturk completed his BS (2011) and MS (2014) degrees in Food Engineering at Middle East Technical University in Turkey. He also has an MBA (2013) from the same university. He received his PhD (2019) from the Department of Food Science and Human Nutrition at the University of Illinois at Urbana-Champaign, where his research focused on modeling of water transport in food products during the drying process. He joined Dr. Bruce Hamaker's lab in April 2019 as a postdoctoral research associate and works on projects related to the structure and functionality of proteins and starches.



Shiyu Li received her PhD (Preventive Veterinary Medicine) from the Academy of Military Medical Sciences in China, and her MS and BS in Food Science. In 2017 she joined Dr. Lavanya Reddivari's group as a visiting scholar for a year, and is currently working as a postdoctoral research associate in the same lab. Her research focuses on the anti-inflammatory properties of food-based bioactive compounds and the role of gut bacteria.

Jongbin Lim earned his MS in Food Science and Technology from Sejong University in South Korea. He joined Dr. Bruce Hamaker's lab group in August 2014 to begin his doctoral work. His research was on the moderation of starch digestion rate by inhibition of digestion enzymes and the development of glycemic carbohydrates to digest in the ileal region of the small intestine for stimulation of physiological feedback systems. He graduated with his PhD in 2019 and continues on as a postdoctoral researcher in Dr. Hamaker's lab.

Yony Román Ochoa received his BS in Chemistry and MS in Chemical Sciences at University of Antioquia, Colombia. In 2017, he finished his PhD in Sciences–Biochemistry at the Federal University of Paraná (UFPR), Brazil, working on structural characterization, chemical modification, and anticoagulant and antithrombotic activities of polysaccharides. In 2018, he was a postdoctoral researcher in Sciences–Biochemistry in carbohydrates and their application as anticoagulant and antithrombotic regulators. In 2019, he joined Dr. Bruce Hamaker's lab as a postdoctoral researcher working on screening and Health Risk Assessment of heavy metals in local staple food-based processed products in the Arequipa Region of Peru. Currently, he works to develop food processes to reduce heavy metal contamination to safe levels, and to evaluate their effects on dietary fiber fermentation by the gut microbiota.

Whistler Center Staff

Dane Deemer received his bachelor's degree in Biology (Anthropology) from Albion College and his master's in Cell & Molecular/ Computational Biology from Oakland University. Before joining Purdue, his research focused on diverse aspects of human and mammalian pathophysiology. Dane joined Dr. Stephen Lindemann's lab in March 2020 as a computational biologist and project manager. His current research has shifted toward investigating diet-microbiome interactions through both computational and wet-lab techniques. Dane's main area of expertise is in big data analysis pipeline creation, such as creating automated metagenomic/NGS pipelines.

Aminata Diatta received a BS in Natural Sciences in 2002 and a pre-doctorate diploma in Chemistry and Biochemistry of Natural Products in 2006 from Cheikh Anta Diop University, Dakar, Senegal. She worked on the theme: "Characterization of three varieties of sorghum (S. bicolor), composition and aptitude to form rolled flour products". She joined Dr. Bruce Hamaker's group in fall 2015 and successfully defended her MS in May 2018. Her work focused on "Using corn zein to improve the quality of gluten-free bread". Currently she works temporarily as a lab assistant in Dr. Hamaker's lab.

Angie Gutterman joined the Whistler Center as the Center's coordinator in September 2019. She received her bachelor's degree in business administration from Butler University in 1985. Angie is enjoying working with graduate students, postdocs and our industrial members.

Bhavesh Patel received a BS degree in Dairy Technology from Gujarat Agricultural University and an MS degree in Food Technology from Central Food Technological Research Institute, both in India. His PhD in Food Science is from Pennsylvania State University. Bhavesh joined Drs. Osvaldo Campanella and Bruce Hamaker's groups in 2008 and has worked on the development of processes for isolation of corn fiber polysaccharides and enhancing their functional properties, as well as fiber rheology and fiber incorporation into processed foods and gel formation kinetics. He recently conducted a project related to enzymatic conversion of complex polysaccharides into useful industrial and food products. He conducts short-term research projects for Whistler Center member companies.

Anton Terekhov is proficient in analytical chemistry, molecular biology techniques and analytical instruments such as NMR, GCMS, LCMS and FTIR. Anton has more than 10 years of experience in an interdisciplinary laboratory environment, including the fields of analytical chemistry, microbiology, genetics, geology and chemical and civil engineering. His main research area is carbohydrate analysis. He is Director of Analytical Services for the Whistler Center.

Kristin Whitney completed her BS in Food Science and MS in Cereal Science at North Dakota State University. Kristin has worked in the Department of Plant Sciences at NDSU since 2006. She is a research specialist in the Carbohydrate Chemistry and Wheat Quality group under the supervision of Dr. Senay Simsek. Kristin assists with research projects related to structure-function relationships of carbohydrates and wheat and cereal grain macromolecules.

Our People, Our Projects

Campanella

1. Modeling the Microbial Community in the Gut: The Basics
2. Modeling Inactivation Parameters of Spore Cells Subjected to Cold Plasma and Other Non-Thermal Processes
3. Innovative Green Clean-in-Place Technology with Microbubbles

Hamaker

4. Fabrication and Modification of Dietary Fibers for Targeted Functions in the Gut
5. *In Vitro* Gut Fermentation Studies on Dietary Fibers
6. Specificity of Dietary Fiber Structures to Support of Gut Bacteria
7. Investigations on Slowly Digestible Glycemic Carbohydrates
8. Cellular and Physiological Response of Slowly Digestible Carbohydrates
9. Grains and Zein Viscoelasticity

Jones

10. Protein Fibrous Structures as Physical Simulacrums of High-MW Glutenin
11. Effect of Protein Hydrolysis and Conjugation on Functionality of Corn Protein

Kokini

12. Applications of Structural Bioinformatics in Understanding Molecular Origins of Gels and Emulsions Made from Pea Protein
13. Relationship of Medium Amplitude Oscillatory Shear (MAOS) Measurements of Soft, Hard, Semolina Dough
14. Development of Cold Extrusion Process for the Functionalization of Pea Protein
15. Investigating the Nonlinear Behavior of Cream Cheese and Sour-Cream
16. Soy Protein Isolate-Based Sensors for the Detection of Food Analytes
17. Efficiency of Pectin-Chitosan and Gelatin-Chitosan based Edible Coatings on the Quality and Post-Harvest Preservation of Fruits and Vegetables

Lindemann

18. Bran Arabinoxylan Chemical Structure Effects on Fermentation by Gut Microbiota
19. Species, Particle Size, and Processing Effects on Wheat Bran Fermentation by Gut Microbiota
20. Influence of Resistant Glucan Structure on Fermentation by Gut Microbiota
21. Structure Effects on Competition for Oligosaccharides by Gut Microbiota

Martinez

22. Understanding Structure-Function Relationships of Pectic Polysaccharides from Fruits and Pulses
23. Methodological Optimization to Characterize Pulses in Terms of Texture and Health-Promoting Compounds
24. Revalorization of Oil Seed Cold Pressed Cakes through Lipid Stabilization
25. Whole Muscle Tissue Engineering using Bio-Polymeric Materials from Plants
26. Upcycling Food and Agricultural Waste into Biodegradable Packaging Materials

Mauer

27. Starch Properties in Different Environments

Narsimhan

28. Volume Fraction Dependence of the Elastic Behavior of Starch Suspensions
29. Effect of Oligosaccharides on Starch Swelling
30. Synergistic Effect of Low Power Ultrasonication on Antimicrobial Peptide Action

Reddivari

31. Anti-Inflammatory Effects of 3-deoxy and 3-hydroxy flavonoids – Role of Gut Bacteria
32. Anthocyanin and polysaccharide complexes: Stability of anthocyanins

Simsek

33. Inclusion Complexes of β-Cyclodextrin with Selected Food Phenolic Compounds
34. Carbohydrates & Nutritional Quality of Hulled Wheats
35. Value Adding Strategy for Nut-Byproducts in Starch-Based Biodegradable Packaging Material

Yao

36. Molecular Rotor-based Characterization of Biopolymers in Emulsions
37. OHPP to Improve the Bioavailability of Niclosamide, a Potential COVID-19 Therapeutic

Project Summaries

1 Modeling the Microbial Community in the Gut: The Basics

P.I.s: O.H. Campanella, J. Welti-Chanez (Tecnologico de Monterrey, Mexico)

Researcher: Viridiana Tejada Ortigoza, Post-doc (Tecnologico de Monterrey, Mexico)

Collaborator: Bruce Hamaker

Objectives: To understand the nature of microbial communities' interactions and how these might impact the host's health (or disease).

Progress: A book edited by Jorge Welti-Chanes, Sergio O. Serna Saldivar, Osvaldo H. Campanella and Viridiana Tejada-Ortigoza was published in 2020. The book, titled "Science and Technology of Fibers in Food Systems," was published by Springer Nature. It covers practical and scientific aspects related to the chemistry, analysis, technology, processing, functionality, and health implications of fiber components associated with different food matrices and is designed for scientists, students, food product developers, nutritionists, medical doctors, and health practitioners interested in the field of edible food fibers. The first part introduces concepts of fiber components intended to reduce the caloric density of foods, to improve gastrointestinal function, and levels of antioxidants that protect mammalian systems against oxidative stress. Moreover, different dietary fiber components act as prebiotics that improve the microbiota or microbiome present in the hindgut. A review article incorporating aspects of engineering to describe the dynamics of microbial species present in the community and their interactions is being completed. The review also provides a molecular view on metabolic reactions where metabolite production (e.g., SCFA and vitamins) and consumption, as well as physical parameters such as diffusion of nutrients through the microbial species or vice versa, are considered. Several models involving computational analyses are being reviewed. The models are based on parameters obtained experimentally through in vitro or in vivo studies. The main goal of the review is to identify model(s) where general rules are considered involving the bulk/convective movement of substrates as well as the diffusion of microorganisms and chemical species and how they are affected by viscosity. Suitable models might be applied to gain practical means to model the microbial community in a systematic way by simplifying the use of this complex information, not only for the scientific community but also for the industry.

2 Modeling Inactivation Parameters of Spore Cells Subjected to Cold Plasma and Other Non-Thermal Processes

P.I.: O.H. Campanella

Researcher: Gabriella Mendes Candido de Oliveira, PhD student

Collaborators: F. San Martin, A. Deering (Food Science), Tony Jin (USDA)

Objectives: This project aimed to develop experimental and modeling tools associated to a wide range of applications that can assist the food industry to predict, control and improve processing performance, which will ultimately aid in the management of food safety programs. The food industry is constantly trying to adapt to consumer expectations demanding that foods are free from potentially harmful microbes, but to have also fresher and more natural foods. The project dealt with alternative food processes such as microwave heating, pulsed electric fields, and cold plasma able to meet those demands. Mathematical modeling was extensively used as a valuable tool for a quantitative assessment of process efficacy that can support food safety decisions considering novel food processing technologies.

Progress and Final Results: Cold plasma was one technology investigated in the process. During plasma processing there is the generation of reactive species that promote the inactivation of vegetative and spore-forming organisms. The extreme resistance of spore cells often requires harsh (e.g., heat) treatments which in turn are likely to cause adverse effects on the freshness, nutrition and quality of foods. However, due to the relatively mild conditions of the cold plasma processes and the generation of highly oxidative gas species, the technology offers the opportunity to inactivate spore-forming organisms that present risks in foodborne diseases or food spoilage. Quantitative approaches are essential for assessment of microbial food safety that are required for regulatory approval. One of the major deficiencies in current modeling/quantitative

approaches is the assumption that the concentration of reactive species is constant, which is far from real conditions occurring during the process. The other aspect that is not considered is the fact that despite survival curves are visibly non-linear, first-order kinetics is used. Unfortunately, these shortcomings do not help in the design of real plasma processes**.** The work performed was able to identify a key and major reactive specie that has a time dependent concentration and has effect on the kinetics of microbial inactivation. The approach enabled the determination of a critical gas concentration of that specie, which would provide a threshold value to be employed in the industry to achieve significant microbial inactivation. Thus, the modeling approach provided a useful and practical relationship between the inactivation characteristic of resistant spores with realistic plasma processing conditions.

The use of microwave heating for food pasteurization, as another emerging technology for the inactivation of foodborne pathogens with minimal changes in nutritional attributes, was also studied in this project. Microwave pasteurization may mirror processing variables as those used in traditional pasteurization times, but heating times are shorter and heat penetration is significantly higher. However, the temperature profile in microwave processing is far from constant. Therefore, typical non-isothermal conditions of microwave heating should be included in the modeling analysis. By using these novel approaches, the developed model was able to find a critical temperature above which reduction of pathogenic microbial load is significantly reduced. This will help the food industry in the design of microwave processes, as well as in the decision-making process, to define which variables should be evaluated to ensure that pasteurization is effective and that the 5-log reduction criteria requested by the FDA HACCP guidelines are met.

Pulse Electric Fields (PEF) was other emerging technology investigated in this project. While quantitative approaches had been explored to describe the efficacy of PEF processes, none of the studies performed were able to incorporate all the PEF variables into the modeling analysis. The weakness of currently used methods at the time of the research provided the opportunity for the development of more realistic models that should better assist the design of PEF pasteurization protocols. The study was able to estimate a critical energy density parameter that grouped many operation conditions of the process, such as pulse repetition rates, the electric field strength, the electrical pulse width, the voltage duration, the electrical conductivity of the sample, the product residence time, the geometry of the PEF unit and the process flow rate. With that critical parameter a threshold value above which the process rendered to be more effective was determined. The model was applied successfully to validate data published in the literature for other juices. For the first time, a model was developed and validated, proving its usefulness for the design of PEF processes. Further studies have continued focusing on the sensory quality of the materials. The use of PEF assisted extrusion is also being considered in new project to enhance the digestion and separation of proteins from starch and non-starch polysaccharides (e.g., fibers) from byproducts obtained during the processing of legumes and cereals.

3 Innovative Green Clean-in-Place Technology with Microbubbles

P.I.s: O.H. Campanella, C. Corvalan

Researcher: Nathaniel H. Brown, MS student

Collaborator: J. Lu

Objective: The general objective of this project is to use microbubbles to clean fouled surfaces of processing equipment.

Progress and Final Results: A model was developed to further understand the mechanisms of fouling material detachment and movement of microbubbles. Results clearly demonstrated that microbubbles move due to a phenomenon known as the Marangoni effect, which can create “Marangoni” flows promoted by gradients of concentration of surface-active (surfactant) species located in the interface of the microbubbles. The study contributed to a better understanding of self-induced movement of microbubbles generated by these Marangoni flows. The simulated surfactant spreading along the bubble interface was benchmarked against experimental results to limit speculative predictions. The investigation also advanced in-depth active bubble propulsion and affected by initial surfactant coverage, surfactant strength, and capillary radius on the axis of propulsion. Results showed that the extent of the contaminated area of the interface of the microbubble has a strong effect on the total bubble displacement and speed, with smaller initially contaminated regions typically achieving faster speeds and larger displacements.

Understanding the extent of Marangoni propulsion due to chemical species has been recognized in important industrial and biomedical processes. These range from the cleaning of biomes and industrial equipment to drug capsules and microfluidic device propulsion. The governed transport of surfactants on the bubble interface is also seen in environmental and natural processes such as the cleaning of oil spills and microorganisms swimming. Some of these aspects also addressed in Project 3.

4 Fabrication and Modification of Dietary Fibers for Targeted Functions in the Gut

P.I.s: B. Hamaker, B. Reuhs

Researchers: Emmanuel Ayua, PhD student; Nusebye Bulut, PhD student; Na-na Wu, Visiting Scientist; Thaisa Cantu-Jungles, Postdoc

Collaborators: A. Keshavarzian (Rush University Medical School, Chicago); S. Lindemann

Objectives: Fermentable dietary fibers have the potential to produce positive short chain fatty acid (SCFA) changes in the colon, such as elevated levels of butyrate or propionate, and desired changes in microbiota composition by favoring certain bacteria or bacterial groups. In a broad sense, fibers that are fermentable are beneficial and have prebiotic potential. Our interest here is in finding ways to either improve fermentability and function of fibers through use of food technology methods or to fabricate new fiber materials with targeted function.

Progress: Our research activities in this area have concentrated on processing or enzymatic methods to increase accessibility of insoluble fibers to bacteria and, in turn, to increase fermentability and SCFA production. We also have taken the approach of fabrication of fiber materials with good fermentability and targeted action to beneficial Clostridia butyrate-producing bacteria. Last year, N. Bulut's work was reported on fabrication of an arabinoxylan-based plant cell wall-like material where internalized pectin supported specific Clostridia bacteria. In 2020, Emmanuel Ayua completed his work on the effect of extrusion on corn bran fermentability. In this year, T. Cantu-Jungles published the paper "Microwave treatment enhances human gut microbiota fermentability of isolated insoluble dietary fibers" in *Food Research International*. This work showed that microwave treatment of fruit fiber both increased its fermentability and certain butyrogenic bacteria. This is a recurring theme of recent studies in our laboratory and corroborates other work showing that fermentable matrix fibers support butyrate-producing Clostridia and increase butyrate amount.

In 2020, E. Ayua completed his study on the effect of twin-screw extrusion on gut microbiota fermentation of corn bran. Corn bran is one of the least fermentable of the brans, and this is believed to be due to the dense packing of the arabinoxylan and cellulose-based cell wall matrix. We hypothesized that this dense cell wall matrix can be opened for better fermentation by applying extrusion. *In vitro* fermentation of test materials was conducted on stool samples from three donors. Extrusion increased total SCFAs and produced individualized donor effects on the gut microbiota, and in a number of cases increased butyrogenic bacterial groups such as in Donor 3, Lachnospiraceae was increased at 20 and 25% feed moistures at 200 RPM and 30% feed moisture at 400 RPM compared to non-extruded bran. Changes, though, overall were modest. N. Wu also conducted an *in vitro* fecal fermentation on extruded rice samples processed at her institution in Beijing, and results will be reported next year.

We have tried in the last year to figure out a way to make 3-D printed insoluble fiber matrices, but the conceptual basis of this is still in process. Our thinking is that printed materials could be designed to target certain beneficial gut bacterial groups.

5 *In Vitro* Gut Fermentation Studies on Dietary Fibers

P.I.s: B. Hamaker, B. Reuhs, S. Lindemann

Researchers: Enosh Kazem, MS student; Thaisa Cantu-Jungles, Postdoc; Na-na Wu, Visiting Scientist

Collaborator: A. Keshavarzian (Rush University Medical School, Chicago)

Objectives: Fermentable dietary fibers have the potential to produce positive short chain fatty acid (SCFA) changes in the colon, such as elevated levels of butyrate or propionate, and desired changes in microbiota composition by favoring certain bacteria or bacterial groups. Our interest in these studies is in understanding how dietary fibers act with the gut microbiota.

Progress: In 2020, E. Kazem completed his study on a screening of over 30 mostly whole food fibers, and successfully defending his MS thesis work. Added was microbiota analysis showing different responses among the three donors tested, though with similar and high short-chain fatty acid production. In this year, carbohydrate structural analysis was performed on the soluble and insoluble tuber, cereal, and pulse fibers with the aim of understanding how chemical and physical structures of the whole food fibers interact with fecal fermentation fatty acid and microbiota responses. Findings will be reported in next year's report.

Another study was initiated on the potential of mixtures of fibers to be developed, whereby fiber components target different important groups of bacteria in the microbiota community. Fecal fermentation experiments were conducted and findings are pending.

The publication of X. Zhang "High fiber fine structure specificity to gut bacteria driven by corn genotypes but not environment" was published online in *Carbohydrate Polymers*.

6 Specificity of Dietary Fiber Structures to Support of Gut Bacteria

P.I.s: B. Hamaker; S. Lindemann

Researchers: Thaisa Cantu-Jungles, Postdoc; Tianming Yao, PhD student

Collaborators: A. Keshavarzian (Rush University Medical School, Chicago); E. Martens (University of Michigan Medical School); M. Tuinstra (Purdue University)

Objective: To understand the relationship between dietary fiber chemical and physical structures and their alignment to support specific gut bacteria and bacterial groups, and how gut bacteria community structure affects fiber response. This leads to the possibility of predictable outcomes of fibers in individuals with different microbial community structures.

Progress: A study by T. Yao in collaboration with Eric Martens at University of Michigan was continued with the aim to understand how polysaccharide structures are degraded by *Bacteroides spp*. Sequences of disassembly of four soluble arabinoxylans of different chemical structures by *B. cellulosilyticus* and *B. ovatus* were assessed to map how these major xylan degraders differently utilize these carbohydrates. Transcriptional analysis was done on specific degrading enzyme-encoded genes. The objective of this work is to gain a fundamental view of polysaccharide degradation so that a better understanding can be developed of alignment of fiber structures to gut bacteria.

T. Cantu-Jungles published an important paper for the lab ("A new view on dietary fiber selection for predictable shifts in the gut microbiota") in the journal *mBio,* presenting a concept that dietary fibers can be regarded in a hierarchical sense of low to high specificity relating their chemical and physical structures to gut function. Simple and more non-specific fibers would have varying response in individuals dependent on their gut microbiota community differences, while complex and more specific fiber structures, that also may be more uncommon, would have more consistent response. In experimental work with four fibers defined from low to high specificity, this theory was validated. Due to its targeted function towards a Clostridia group butyrogenic species and a *Bacteroides* propiogenic species, among 10 donors there was not only a consistency (or predictability) of response, but also a more robust response than was observed with the low specificity fiber. A paper was submitted and was in review.

Other papers were published on fiber specificity in 2020, including one by E. Ayua, "Whole grain cereal fibers and their support of the gut commensal Clostridia for health" in *Bioactive Carbohydrates and Dietary Fibre,* and by visiting scientist F. Gu, "Fecal microbiota responses to rice RS3 are specific to amylose molecular structure" in *Carbohydrate Polymers*.

7 Investigations on Slowly Digestible Glycemic Carbohydrates

P.I.s: B. Hamaker, M. Ferruzzi

Researchers: Anna Hayes, PhD student; Sarah Corwin, PhD student; Pablo-Torres Aguilar, PhD student; Jongbin Lim, Postdoc; Fang Fang, Postdoc

Collaborators: B.H. Lee (Gachon University, South Korea); G. Zhang (Jiangnan University); B. Nichols (Baylor College of Medicine, Houston); R. Quezada-Calvillo (University of San Luis Potosi, Mexico); D. Rose (University of Waterloo, Canada); Amy Lin, (A-Star, Singapore)

Objective: To design slowly digestible glycemic carbohydrates, and to investigate an inhibitor approach, for low glycemic response and with locational digestion into the small intestine ileum to activate the ileal brake and gut-brain axis physiological responses that promote satiety.

Progress: In this reporting year, S. Corwin completed her thesis work on slowly digestible a-glucans and the revealing of relative differences in Glc-Glc linkage type related to human data, but due to confidentiality issues will not be reported until next year. A. Hayes finished data analysis on a human study conducted at Purdue showing some moderation in postprandial glycemia with pearl millet foods (Hayes, et al., "Some pearl millet-based foods show potential to promote satiety and reduce glycemic response in humans" *British Journal of Nutrition*). We continue to investigate carbohydrate foods and their digestion rates to moderate glycemic response and activate the satiety-related physiological responses.

8 Cellular and Physiological Response of Slowly Digestible Carbohydrates

P.I.: B. Hamaker

Researchers: Marwa El-Hindawy, Postdoc; Jongbin Lim, Postdoc; Anna Hayes, PhD student; Pablo Torres Aguilar, PhD student

Collaborators: B. Nichols (Baylor College of Medicine, Houston); Roberto Quezada-Calvillo (University of San Luis Potosi, Mexico); David Rose (University of Waterloo, Canada)

Objectives: To understand the cellular and physiological responses to slowly digestible carbohydrates (SDCs) that might have value in the area of controlled glycemic response, satiety control and the concept of sustained or extended energy release, and enteroendocrine L-cell triggering.

Progress: A notable finding in this area centered on work by A. Hayes and collaborator Buford Nichols on SDCs and energy usage of the body. Using respiratory exchange ratio data from a range of mouse studies, they showed that SDCs appear to affect the oxidation of fat or carbohydrates for energy and how adept the body is at switching between these sources. This promising new line of research and results will be reported next year. M. El-Hindawy also showed in her mouse studies on our fabricated slowly digestible starch microspheres that fat deposition was less when lean mice were fed an obesogenic diet containing the microspheres or obese animals were fed a low-fat diet for weight reduction.

J. Lim completed his studies showing that a-amylase inhibition causes starch to be locationally digested into the ileal (distal) portion of the small intestine, and by so doing that the enteroendocrine L-cells could be activated. Plasma GLP-1 was high and extended and, in a long-term mice study, resulted in lower food intake and weight gain. This important study showed how precise moderation of starch digestion can activate the gut-brain axis for satiety control and weight management. Pablo Torres Aguilar started a human study, that was delayed because of the Covid-19 pandemic, to test the hypothesis that feeding SDC over a 3-week period may condition individuals to be more responsive to SDCs for appetite control.

Two papers from past work in this area of physiological response to SDCs were published in this period, both from L. Hasek – "Conditioning with slowly digestible starch diets in mice reduces jejunal α-glucosidase activity, and glucogenesis from a digestible starch feeding" in *Nutrition*, and "Carbohydrates designed with different digestion rates modulate gastric emptying and glycemic/insulinemic responses in rats" in *International Journal of Food Sciences and Nutrition*.

9 Grains and Zein Viscoelasticity

P.I.: B. Hamaker

Researchers: Oguz Ozturk, Postdoc; Yony Roman Ochoa, Postdoc

Collaborator: Osvaldo Campanella (The Ohio State University)

Objectives: This collection of different projects includes: 1) understanding the physicochemical basis for retained starch in the corn wet-milling fiber fraction, 2) studies on viscoelastic corn zein networks for plant-based protein meat analogues, and 3) investigation of heavy metal accumulation in grains in the southern Perú mining areas.

Progress: O. Ozturk completed his research on retained starch in the corn wet-milling fiber fraction using FTIR and Raman spectroscopy, confocal microscopy, and other methods to reveal ways to increase starch yield. This project, funded by Novozymes, had one paper published in the period (Ozturk et al., "Protein matrix retains most starch

granules within corn fiber from corn wet-milling process", *Industrial Crops & Products*) and another submitted. Oguz started work on another project, funded through USDA FFAR, on using corn zein proteins to form viscoelastic networks in plant-based protein meat analogues. This work will be reported next year.

Y. Roman Ochoa and co-investigators in Arequipa, Perú, as part of the Purdue-UNSA NEXUS project, completed a study on potential of heavy metal contamination in cereal grains (maize, rice), pseudocereals (quinoa, amaranth), and legumes in different areas (mountains, irrigated lands, coastal areas) of southern Peru. While nearly all of the grains had low and acceptable heavy metal contents, a few locations showed rice with elevated cadmium and arsenic, and some processed cereals were found to have relatively high levels of lead. Results are reported in Roman-Ochoa et al., "Heavy metal contamination and health risk assessment in grains and grain-based processed food in Arequipa region of Peru", *Chemosphere*.

Additionally, a past study on corn zein aggregation and β-sheet structuring was published, Erickson et al., "Corn zein undergoes conformational changes to higher β-sheets contents during its self-assembly in an increasingly hydrophilic solvent" *International Journal of Biological Macromolecules*.

10 Protein Fibrous Structures as Physical Simulacrums of High-MW Glutenin

P.I.: O.G. Jones

Co-P.Is.: O.H. Campanella, Gordon Selling (USDA, Agriculture Research Station), B.H. Hamaker

Researchers: Enrico Federici, PhD student, Da Chen, Postdoc

Objective: Determine the influence of physical and chemical attributes of fibrous protein assemblies on the mechanical behaviors of water/starch-based mixtures.

Progress: Electrospinning and high-temperature oven treatments of corn storage protein (zein) both improved the elasticity and shear-thinning behaviors when added to starch and wetted as a dough (viscoelastic mass). Effects were not lasting due to dissolution in water, although the effects lasted longer for oven-treated samples. Electrospinning did not induce covalent linkage among zein, while high temperature treatments did. Both caused mild changes to zein secondary structuring. Other commodity proteins and small molecule plasticizers were incorporated within electrospun fibers, which changed the mechanical properties of those fibers. A separate study earlier in the year showed that fibrous structures formed from whey protein were able to enhance the elasticity of starch gels, particularly within potato starch gels in which the protein fibrils could electrostatically associate with phosphate groups of the starch. Fibrous whey protein structures could also be aligned within larger fibers during electrospinning processes, which could offer a pathway to create very robust and stiff fibers in composite, biologically-sourced materials.

11 Effect of Protein Hydrolysis and Conjugation on Functionality of Corn Protein

P.I.: O.G. Jones

Researcher: Wanying He, Visiting Scholar

Objective: Determine the effect of protein glycosylation on function of corn protein.

Progress: Corn protein was successfully hydrolyzed and covalently modified with short polyglucosamine (chitosan) chains using enzymatic reactions. Solubility in water at neutral pH, emulsification, and foaming properties were nearly doubled when compared to hydrolyzed corn protein without saccharide attachment. New studies have been initiated to identify functional improvements to hydrolyzed corn protein with other attached saccharide chains, as well as the influence of the modification on interactions with other media components.

12 Applications of Structural Bioinformatics in Understanding Molecular Origins of Gels and Emulsions Made from Pea Protein

P.I.: J. Kokini

Researchers: Christabel Hartanto, undergraduate student; Harrison Helmick, PhD student

Objective: This research aims to develop relationships between bioinformatic models of pea protein and give molecular insight on how pea protein forms gels and emulsions.

Progress: This work is part of USDA grant that aims to develop structure-function relationships of pea protein and how structure can be modified in order to achieve targeted end uses. In this work, a series of homology models have been generated for pea protein, as well as other pulses, from global sources in order to compare the amino acid similarity and differences based on cultivar and growing region. These models are then analyzed for a number of bioinformatic features that are thought to correlate with experimental properties. It has been found that the surface properties of the protein three-dimensional structure correlates well with experimental values like emulsion activity index, surface hydrophobicity, and zeta potential. This has shown the potential of bioinformatics to predict end-use of proteins based on a model generated from the amino acid sequence of the protein. Future work will involve additional surface analysis and the generation of weighted-average predictive models for pea protein behavior in both gels and emulsions based on the protein primary sequence.

13 Relationship of Medium Amplitude Oscillatory Shear (MAOS) Measurements of Soft, Hard, Semolina Dough

P.I.: J. Kokini

Researcher: Merve Yildirim, PhD student

Objective: This project aims to understand the relationship between the nonlinear behavior of soft, hard, and semolina dough by using medium amplitude oscillatory shear (MAOS) measurements.

Progress: Information on medium amplitude oscillatory shear (MAOS) measurements of food products is limited in the literature. With this research, rheological characteristics of soft, hard and semolina flour dough were characterized by amplitude sweep at various frequencies. SAOS, MAOS, and LAOS regions were detected by harmonic intensities (I_2, I_3, I_5) of stress responses with respect to the fundamental harmonic. Nonlinear characteristics of materials were plotted with respect to amplitude of the deformations and applied frequency (Pipkin plot), providing clear distinction of linear, intrinsic nonlinear and nonlinear regions of dough. The dough samples were optimized with changing water contents so that each dough possessed similar linear properties. Nonlinear properties characterized by MAOS measurements showed that semolina dough had resilient structure that required higher magnitudes of frequencies and amplitude.

14 Development of Cold Extrusion Process for the Functionalization of Pea Protein

P.I.: J. Kokini

Researchers: Sarah Ettestad, undergraduate student; Harrison Helmick, PhD student

Objective: This research develops a process for low temperature functionalization of pea protein involving sub-zero temperatures and shear forces in extrusion and the physicochemical characterization of that extrudate.

Progress: It is well known that proteins denature as the result of heat and other processing techniques, but, as first suggested in 1930, globular protein has also been shown to denature at low temperatures. This interesting phenomenon is driven by the stabilizing entropy on protein three-dimensional structure. In this work, we aim to utilize the intermediate unfolding state of proteins caused by cold denaturation. In this work, we have subjected pea protein to cold temperatures and shear forces and characterized changes in secondary structure, zeta potential, particle size in water, and oil binding capacity. We have shown that cold denaturation does occur in pea protein, and it may lead to more hydrophobic exposure, indicating that cold denatured protein could be used to prepare novel gels and emulsions. In future work, we will expand this process into a low temperature extrusion environment and test the extrudate for changes in their ability to form stable gels and emulsions.

15 Investigating the Nonlinear Behavior of Cream Cheese and Sour-Cream

P.I.: J. Kokini

Researchers: Louie (Anh) Le, undergraduate student; Merve Yildirim, PhD student

Objective: This research aims to study the nonlinear rheological behavior of commercial cream cheese brands by analyzing the LAOS results.

Progress: Past studies have found that there are significant differences in the textural properties of cheese made with different fat contents. In this study, two cream cheese samples varying in fat content but with otherwise comparable ingredients were taken from the same manufacturer. Hence, LAOS measurements of these two samples revealed the role that fat plays in the rheological properties of cream cheese. Both cream cheese samples had strain-stiffening and shear thickening behavior when they enter the nonlinear viscoelasticity region. At small strain amplitude, the whole-fat cream cheese sample had a relatively stronger structure than the low-fat version but decayed faster with increasing amplitude. Deeper data analysis and SEM network quantification are being carried out to study the structural breakdown of these two samples in more details.

16 Soy Protein Isolate-Based Sensors for the Detection of Food Analytes

P.I.: J. Kokini

Researcher: Cindy Mayorga, MS student

Objective: This research aims to create a SERS biosensor platform based on electrospun nanofibers from soy protein isolate (SPI) to detect analytes in food.

Progress: Soy protein isolate (SPI) is one of the most abundant plant proteins in the world that consists of globulin structures. SPI can be used to fabricate electrospun nanofibers if in combination with other polymers. Aspects of these nanofibers depend on solution parameters, such as the viscosity and concentration. In contrast, other parameters during processing, such as voltage and pressure, can directly impact the morphology of the nanofibers. When optimal parameters are identified, well-formed and abundant nanofibers can successfully be obtained. In the second part of this project, the fabricated SPI nanofibers will be decorated using noble metal nanoparticles such as gold or silver to functionalize the nanofibers' surface and serve as a Surface-enhanced Raman spectroscopy (SERS) biodegradable platform for the detection of analytes present in foods.

17 Efficiency of Pectin-Chitosan and Gelatin-Chitosan based Edible Coatings on the Quality and Post-Harvest Preservation of Fruits and Vegetables

P.I.: J. Kokini

Researcher: Jaime Fernandez, Visiting Scholar, and Cindy Mayorga, MS student

Objective: To evaluate the efficacy of pectin-chitosan and gelatin-chitosan-based food coatings on the quality and post-harvest preservation of fruits and vegetables.

Progress: In the food industry, the use of synthetic polymers has become one of the most widely used materials for fruit and vegetable packaging; however, these polymers are non-biodegradable, which generates significant environmental damage. Due to the non-degradability of these synthetic compounds, there has been a growing interest in the research of natural materials to manufacture biodegradable edible coatings. For this reason, the efficacy of a food coating based on chitosan-pectin and chitosan-gelatin in the quality and post-harvest preservation of fruits and vegetables will be evaluated. This research project is developed in three phases: first, the preparation phase, which consists of the formulation and fabrication of the food coatings. In the second phase, the fabricated chitosan-pectin and chitosan-gelatin coatings' characterization is assessed to determine the functionality and mechanical properties of the fabricated edible coatings. Finally, the edible coatings' feasibility is evaluated by the immersion technique to fruits and vegetables, and the physicochemical and visual analysis of these foods are studied. It is expected to be able to preserve the quality and shelf life of the treated fruits and vegetables compared to the control samples.

18 Bran Arabinoxylan Chemical Structure Effects on Fermentation by Gut Microbiota

P.I.: S. Lindemann

Collaborator: S. Simsek

Researchers: Tianming Yao, PhD student; Adam Quinn, PhD student; Dane Deemer, staff scientist; Laura Libera, undergraduate student

Objectives: 1) To identify interrelationships between fine fiber structures of dietary fibers and the microbial consortia that degrade them and standardize them for use in fiber-microbiome studies, 2) Genome sequencing and reconstruction of model communities for use in systems biology analyses, and 3) Determination of consortial stability over time in carbohydrate-consuming consortia

Progress: T. Yao continued his experiments using structural variants of sorghum arabinoxylan (SAX), either from different lines of sorghum (i.e., red vs. white) or enzymatically debranched SAX. Assisted by D. Deemer, T. Yao was able was to sequence and reconstruct member genomes from red and white SAX-consuming consortia and determined that fine carbohydrate structure differences among red and white SAX supported a different degree of microbial diversity over sequential passages. Specifically, red SAX maintained significantly greater diversity than did white SAX over sequential batch cultures, reflected in both the 16S amplicons and genome reconstructions from metagenomes. Analysis is presently underway to determine the different gene content selected for by red SAX. Interestingly, despite strong inter-individual variation in initial microbiome structures, fecal microbiota from multiple individuals converged as consortia formed, suggesting that individuals retain organisms able to perform these functions (even if not particularly abundant) and standard gut microbiome assays may simply not sample in sufficient depth to identify them in complex samples. Further, T. Yao determined that enzymatic processing of white SAX with arabinofuranosidases *in vitro* changed the targeting of these molecules to microbiota (with respect to their ability to grow in consortia), both with respect to fermenting microbiome composition and metabolic outputs. Recently, A. Quinn has adapted a similar approach to understanding how similar structural differences might manifest across different wheat species of ancient and modern origin. L. Libera and T. Yao continue to investigate the long-term compositional and functional stability of these consortia; if stable, these communities can be shared broadly across the research enterprise to standardize mechanistic studies of arabinoxylan-microbiota interactions.

19 Species, Particle Size, and Processing Effects on Wheat Bran Fermentation by Gut Microbiota

P.I.: S. Lindemann

Collaborators: B. Hamaker, S. Simsek

Researchers: Miguel Alvarez Gonzales, PhD student; Adam Quinn, PhD student

Objectives: 1) Determine the degree to which the fermentation of a bran particle depends upon its size, 2) identify mechanisms by which particle size might influence the structure and function of gut microbiota, and 3) determine how different mechanisms of mechanical processing might influence microbiota responses to bran particles.

Progress: M. Alvarez performed experiments to determine to what extent the chemical composition and microbial fermentation of variously-sized bran particles was influenced by the processing method (roller mill, hammer mill, disc mill, cyclone mill, or stone mill) used to reduce the size of those particles. He determined that the arabinoxylan structures isolated from differently sized particles depended on the milling method used to generate them, especially with respect to degree to which backbone regions were substituted. These chemical composition differences translated into differences in microbial responses – identical fecal microbiota converted particles (even those of the same size) to different metabolic outcomes with respect to short-chain fatty acid (SCFA) production. Interestingly, the outputs of differently milled bran fractions did not exhibit the same trajectories of SCFA production with size. These data strongly suggest that different milling methods expose different resources and create different niches for microbiota. Further, Miguel performed sequential batch transfers using wheat bran as the sole carbon source to identify whether these differences in milling method-induced resource availability compound and select for distinct microbial communities. 16S rRNA gene amplicon sequencing is presently underway to identify the extent of impact on the fermenting microbiota.

Recently, A. Quinn began a project to identify the extent to which bran structural features of relevance

to the microbiome have been altered by selection of production wheat lines over time. To accomplish this, he has performed trial comparison of some ancient and modern wheat lines, revealing differences in arabinoxylan structure and bran fermentation profiles. These encouraging data suggested a larger trial, so, in collaboration with S. Simsek's group at NDSU, multiple field replicates of modern and ancient lines were grown. Characterization of the structure and fermentation of these species is now ongoing in our laboratory.

20 Influence of Resistant Glucan Structure on Fermentation by Gut Microbiota

P.I.: S. Lindemann

Collaborators: B. Hamaker, B. Reuhs

Researchers: Arianna Romero, MS student; Mai Nguyen, MS student; Renee Oles, undergraduate student

Objectives: To determine whether different glucans select for different microbiota and result in different metabolic outcomes.

Progress: A. Romero performed an experiment with three donors in which each donor's microbiota was exposed to 12 different resistant glucan structures in *in vitro* batch fermentations, measuring pH, gas production, SCFAs, and microbial community structure via 16S rRNA amplicon sequencing. She observed that 1) metabolic outcome from the same resistant glucan varied across donors (e.g., with respect to relative propiogenesis vs. butyrogenesis) and microbial responses. However, across donors some taxa were repeatedly selected by certain dextrin structures, suggesting that there are specificities in interactions among resistant glucans and the organisms which best consume them. Additionally, antagonism/competition among organisms could be observed, in which some organisms are seen to increase in relative abundance at the expense of others. These changes in relative abundance were strongly context-dependent – microbiota from different initial samples did not respond equivalently to the same glucan structures, suggesting either strain specificity in different individuals or interactions with other members governed microbial growth on these substrates. Together, these data suggest that microbial and associated metabolic responses are emergent properties of fiber-microbiome interactions and are not determined either by fiber structure or microbiome composition alone.

Recently, M. Nguyen continued this work using a sequential batch cultivation approach, which revealed that different glucan structures ferment to different metabolic outcomes, even given an identical inoculum. Work is presently ongoing to identify the extent of the metabolic and microbial dependency upon fine glucan structure.

21 Structure Effects on Competition for Oligosaccharides by Gut Microbiota

P.I.: S. Lindemann

Researchers: Jacob Thompson, PhD student; Anurag Pujari, PhD student; Mehdi Marashi, PhD student; Monique Felix, PhD student; Felicia Sackey, MS student

Objectives: 1) To determine the mechanisms by which structural properties of oligosaccharides influence microbial competition for these carbohydrates, 2) to predictively model competition for oligosaccharides given known consumption properties of microbes, 3) to identify signatures of competition for oligosaccharides in complex microbiomes, and 4) to identify oligosaccharide structure-microbiome competition influences on host physiology at high throughput.

Progress: We recently began a program to understand competition for oligosaccharide substrates among microbiota at a predictive level, using a strong focus of carbohydrate chemistry, microbial ecology, computational predictive modeling, and host physiology. We begin this investigation looking at competition along a single structural parameter (branch length) using chicory inulins as model oligosaccharides that vary only in this dimension. This year, we formulated a draft kinetic model that describes degradation of inulins varying in DP according to assumed species parameters, and M. Marashi is presently working to extend this model to real-world competition between two isolates derived from our previous inulin sequential batch transfer experiments (Yao, et al., 2020, *FEMS Microbiology Ecology*), characterizing kinetic responses to different oligosaccharide structures. F. Sackey has successfully evolved strains able to consume larger inulins. J. Thompson is beginning the process of generating a host-microbiome interactions screening platform, to investigate different combinations of microbiota or metabolites for host impacts. A. Pujari just joined the lab and will work on chemical probing approaches using inulin mimetics.

22 Understanding Structure-Function Relationships of Pectic Polysaccharides from Fruits and Pulses

P.I.: M. Martinez

Researchers: Laura Roman, Postdoc; Natalia Prieto, Postdoc

Collaborators: M. Guo (Shandong Agricultural University), K. Xu (Shandong Agricultural University)

Objectives: To understand the yield and molecular structure of pectic polysaccharides from novel sources and their functionality in food systems.

Progress: We have published several papers about the extraction and purification of functional pectins with optimum molecular conformation (Roman, Guo, et al., 2021; Xu, Martinez, et al., 2020). In Roman, Guo, et al., (2021), we showed that purified hawthorn pectins can be obtained through hot acid extraction followed by an enzymatic step for starch removal, which, in turn, results in pectin demethoxylation (most likely acidic demethoxylation). Results also suggest that the linearity of the polyuronide chain, as quantified by the relative molar ratio of rhamnogalacturonan I (RG-I) to homogalacturonan (HG) and the branching degree of RG-I (i.e., amount of galactan, arabinan and/or arabinogalactan side chains), is critical for successful application in emulsion and gel systems. In Xu, Martinez, et al., (2020), we showed that drying at higher temperatures results in the cleavage of HG domains and, therefore, a decrease in molecular weight, which improves the oil absorption capacity and radical scavenging activity of pectins from okra. On the other hand, this occurrence also decreased their water holding capacity, emulsifying stability and thickening behavior. One additional paper is in preparation focusing on the fine structure of pectic polysaccharides on the mechanical properties of cell walls in pulses and on their cooking quality.

23 Methodological Optimization to Characterize Pulses in Terms of Texture and Health-Promoting Compounds

P.I.: M. Martinez

Researchers: Laura Roman, Postdoc; Natalia Prieto, Postdoc; Joana Pico, Postdoc; Richard Park, MSc student

Objectives: This compendium of publications resulted in the advancement of physical and chemical methods to characterize objectively the texture and the content of health-promoting compounds in pulses

Progress: In Park et al., (2020), we showed that the pressurized RVA 4800 at 130 °C was able to bring about a fully developed viscosity curve that provided rheological indicators that were strongly correlated to the instrumentally measured texture of canned beans. Furthermore, correlations became stronger when brine was used as a cooking medium in the RVA 4800, which was attributed to either or both the partial solubilization of proteins and cell wall polysaccharides and the increase in the denaturation temperature of proteins. Since the instrumental texture of beans is assessed on bean samples after the entire process of soaking, cooking and canning (which would take more than 16 h), the rapid determination of the pasting profile of the whole bean flour could save a significant amount of time (entire analysis in less than 30 min) during the prediction of the texture of canned beans. In terms of health-promoting compounds, we showed that that Solid Phase Extraction (SPE) is highly advised for the analysis of total phenolics in legumes and nuts, even using the Fast Blue BB reaction, which in turn displayed better performance over SPE-Folin–Ciocalteu in terms of sensitivity and slightly better reproducibility (Pico, Pismag, et al., 2020). Last, in Pico, Prieto, et al., (2020), HPAEC/PAD and GC/MS methods were compared for the analysis of galactooligosacharides (GOS) in beans. Stable trimethylsilyl derivatizations for GC/MS analysis were achieved for all GOS, enabling an accurate quantification of raffinose, stachyose and verbascose, with limits of quantification of 4.48–224.31 mg/kg and intra/inter-day repeatabilities <10%.

24 Revalorization of Oil Seed Cold Pressed Cakes through Lipid Stabilization

P.I.: M. Martinez

Researcher: Natalia Prieto, Postdoc

Objectives: The purpose of this research project is to improve the oxidative stability of the lipid fraction in oil seed cold pressed cakes.

Progress: A lipidomic investigation using nuclear and infrared spectroscopy was performed in order to understand the underlying principles of lipid oxidation under hydrothermal challenges. Two research papers are in preparation, which will provide mechanistic understanding and a technological basis for the reintegration of oil seed cakes into the food chain.

25 Whole Muscle Tissue Engineering using Bio-Polymeric Materials from Plants

P.I.: M. Martinez

Researchers: Vasanth Ragavan, Postdoc; Laura Roman, Postdoc; Farzaneh Nasrollahzade, PhD student; Shiva Swaraj, MSc student

Collaborators: John Dutcher (University of Guelph, Canada); Leonid Brown (University of Guelph, Canada)

Objectives: The purpose of this research project is to advance plant-based meat product and/or technology development in simultaneous protein sourcing/characterization, formulation and processing.

Progress: Promising fiber-forming and bulking plant components for continuous manufacture of high-quality High Moisture Meat Analogs (HMAA) were identified. Several papers are in preparation. Future results are expected to result in the development of the scalable production technology of textured plant proteins that are versatile for further conversion into consumer products.

26 Upcycling Food and Agricultural Waste into Biodegradable Packaging Materials

P.I.: M. Martinez

Researchers: Natalia Prieto, Postdoc; Wenqiang Bai, PhD student; Adriana Maribel Aguilar-Torres, PhD student

Objectives: This project aims to understand the supramolecular structure of food and agricultural byproducts (e.g., cell wall-rich pomaces and skins), the isolation of valuable polysaccharides, the investigation of their molecular architecture, and their performance as food packaging materials (e.g., in extruded full bio-composites, films and hydrogels).

Progress: The growth in the use of plastics has brought millions of tons of plastic accumulation in the oceans and landfills, and it is therefore paramount to design renewable-based biodegradable materials with adequate permeability and mechanical properties. Results from this project has advanced our understanding to develop hydrophobic carbohydrate-based full bio-composites with good mechanical properties. Several key building blocks have been identified with promising potential to close the loop of circularity in a post-fossil fuel economy, and several articles are expected to be published in 2021/2022.

27 Starch Properties in Different Environments

P.I.: L. Mauer

Researchers: Travis Woodbury, PhD student; Sarah Pitts, MS student; Adrianna Pilch, MS student; numerous undergraduate students

Objective: To investigate starch properties, including gelatinization and retrogradation, in the presence of a variety of sweeteners, oligosaccharides, and other small molecules, and in environments containing different amounts of water.

Progress: We are investigating the thermal and physicochemical properties of starch in different environments and in the presence of a wide variety of sweeteners, oligosaccharides, and other small molecules to establish relationships between small molecule type and structure, water activity, molecular weight, glass transition temperature, and intermolecular interactions with starch gelatinization, pasting, swelling, and retrogradation traits.

28 Volume Fraction Dependence of the Elastic Behavior of Starch Suspensions

P.I.: G. Narsimhan

Researcher: Prasuna Desam, PhD student

Objective: To characterize the pasting behavior of starch in terms of its structure.

Progress: Starches are incorporated in food products for a variety of reasons, such as stabilizing, thickening, binding and gelling. Starch occurs as discrete granules. Upon exposure to water, starch granules swell when heated. This results in thickening of starch suspension (known as pasting) due to an increase in volume fraction of swollen granules. Starch pasting results in an increase in its viscosity. Therefore, the texture of a variety of food products, such as sauces, puddings, soups, batter mixes, etc., are influenced by pasting. The rheology and texture of starch paste obtained by cooking of starch granules are governed by its swelling. It is, therefore, necessary to quantify swelling in order to predict the rheology of starch paste as well as to develop new food formulations. A methodology is developed to predict the storage modulus of starch paste due to granule swelling, given the physical properties of the starch granule and temperature history. This was tested on experimental measurements of granule size distribution and storage moduli for 8% w/w suspensions of waxy maize, normal maize, waxy rice, normal rice, and cross-linked normal maize – all heated to different temperatures (65 to 90 ^{0}C) and holding times (2 to 60 min). Experimental data of storage modulus versus volume fraction fall onto a master curve when storage modulus is normalized by the limit of storage modulus at full swelling. The limit value of storage modulus was estimated from foam rheology theory and measurements of granule interfacial energy. The master curve, coupled with previously developed theories to predict the granule size distribution over time, allows one to semi-empirically predict the storage modulus due to swelling with a reasonable degree of accuracy.

29 Effect of Oligosaccharides on Starch Swelling

P.I.: G. Narsimhan, O.G. Jones

Researchers: Prasuna Desam, PhD student; Subhadeep Bose, MS student

Objective: To characterize the effect of oligosaccharide on swelling behavior of starch suspensions

Progress: Equilibrium swelling was characterized among 8 wt% suspensions of waxy (WMS) and normal (NMS) maize starch or waxy (WRS) and normal (NRS) rice starch when heated to 80 C at different sucrose concentrations (0 to 30 wt. %). The swelling power reached maximum values of 10.5 and 14.5 at sucrose concentration of 5 wt. % and 10 wt. % for NMS and WRS, respectively, and this increased with sucrose concentration for WMS from 11 to 15.5 and decreased for NRS from 11 to 8.2. The onset temperature of gelatinization increased with sucrose concentration for all starches, whereas enthalpy of gelatinization increased for normal maize starches and did not vary significantly for waxy starches. The interaction parameters for three component system of starch, water and sucrose were inferred from static light scattering. The predicted equilibrium swelling for all starches at different sucrose concentrations using Flory-Huggins theory agreed well with experimental data.

30 Synergistic Effect of Low Power Ultrasonication on Antimicrobial Peptide Action

P.I.: G. Narsimhan

Researcher: M. Fitrityanti, PhD student

Objective: To characterize the synergistic effect of low-power ultrasound and antimicrobial peptides on deactivation of microorganisms.

Progress: Ultrasound can be combined with other physical or chemical treatments such as heat, pressure, and antimicrobial solutions to increase its effectiveness. Ultrasound treatment could drastically improve decontamination action of antimicrobial peptides by increasing its diffusion in liquid systems. Inactivation of Shiga toxin-producing Escherichia coli O157:H7 in PBS (pH 7.4) was performed using three different treatments: ultrasound (14 kHz, 22 kHz, and 47 kHz), antimicrobial peptide Cecropin P1 (20 µg/ml), and a combination of both. The results showed

that the combined treatment at higher power level (22 kHz, 8 watts) for 15 minutes of exposure is more efficient, reducing the cell density to six orders of magnitude, compared to individual treatments. Our results on the effect of different frequencies (14, 22, and 47 kHz) also showed that a combination of higher frequency (47 kHz, 7.5 W) for one minute of exposure with Cecropin P1 was able to deactivate more cells (up to six orders of magnitude) when compared to combined treatment with 14 or 22 KHz ultrasound.

31 Anti-Inflammatory Effects of 3-deoxy and 3-hydroxy flavonoids – Role of Gut Bacteria

P.I.: L. Reddivari

Collaborators: D. Lee and S. Chopra

Researchers: B. Wu, PhD student; S. Li, Postdoc

Objectives: 1) Determine the extent to which 3-deoxy and 3-hydroxy flavonoids suppress chronic colonic inflammation, 2) Determine the role of gut bacterial metabolism in the anti-colitic potential of 3-deoxy and hydroxy flavonoids

Progress: B. Wu and S. Li utilized four maize near-isogenic lines (NIL): a line that lacked both anthocyanins and phlobaphenes, a line containing phlobaphenes, a line containing anthocyanins, and a line that contained both anthocyanins and phlobaphenes. The purpose was to identify the anti-colitis effects of specific classes of flavonoids, anthocyanins and/or phlobaphenes from a whole-food matrix. The phytochemical profiles and the antioxidant potential of the NILs were characterized. The accumulation of both anthocyanins and phlobaphenes contributed significantly to antioxidant capacity compared to maize lines that lacked one or both of the compounds ($p < 0.05$). Results showed that intake of anthocyanin- and phlobaphene-enriched maize diets effectively alleviated dextran sodium sulfate (DSS)-induced colitis in mice via reducing intestinal permeability and restoring barrier function. The 16S rRNA sequencing analysis also revealed a less distinct bacterial community between mice consuming anthocyanin- and phlobaphene-enriched diets and the healthy control compared to the DSS group, suggesting that the role of flavonoids in modulating the gut microbiota was to revive intestinal homeostasis. Microbiota depletion rendered these compounds ineffective against colitis. Lower serum concentrations of several phenolic acids were detected in the microbiota-ablated mice group, indicating that gut microbiota plays a role in flavonoid metabolism and their bioavailability.

32 Anthocyanin and polysaccharide complexes: Stability of anthocyanins

P.I.: L. Reddivari

Collaborator: B. Hamaker

Researchers: W. Fu, MS student; S. Li, Postdoc

Objectives: 1) To determine the extent to which polysaccharides alter anthocyanin stability and bioavailability, 2) to determine whether gut bacterial metabolism of different fibers differ in polyphenol-fiber complexes, 3) identify the mechanisms by which polyphenol and fiber complexes influence gut bacterial metabolism and intestinal barrier function.

Progress: W. Fu and S. Li extracted polyphenols from potatoes and collected anthocyanin and phenolic acid fractions. Complexation efficiency was tested among mixtures of four different polysaccharides (pectin, starch, cellulose and inulin) at different ratios of polysaccharides and anthocyanins and different temperatures. We identified the temperature and ratio that is best suited for the complexes. Our results indicate that the complexation of anthocyanin fraction with pectin increased the stability of anthocyanins. We are currently investigating the anti-colitic effects of complexes *in vivo*.

33 Inclusion Complexes of β-Cyclodextrin with Selected Food Phenolic Compounds

P.I.s: S. Simsek and C. Mayer (University of Duisburg-Essen)

Researcher: Tuba Turkmen, MSc student

Collaborators: B. Rasulev and A. Ugrinov (North Dakota State University)

Objectives: The objective of this project was to form inclusion complexes between β-cyclodextrin (β-CD) and phenolic compounds [trans-ferulic acid (FA), caffeic acid (CA), and p-coumaric acid (CO)] found in whole wheat to mitigate bitterness and improve the quality of whole wheat products.

Progress: Free phenolic acids were extracted from hard red spring wheat bran using 80% aqueous ethanol. The content of the phenolic extract was determined by HPLC. Complexes were formed with the phenolic extract and β-cyclodextrin. Proton nuclear magnetic resonance spectra of wheat bran extract complex contained characteristic peaks for β-CD with shifts corresponding to complex formation with the β-CD. Complexes were verified by mass spectrometry, and the relative amount of complex formation between β-CD and caffeic acid, ferulic acid and coumaric acid in the wheat bran extract was found to be CA > CO > FA. This may be due to the presence of other phenolic acids, such as vanillic acid or other compounds in the wheat bran extract. Infrared spectra and differential scanning calorimetry also showed changes in signature peaks and melting points for phenolic acids, indicating complex formation. A quantitative structure–property relationship (QSPR) model will be beneficial in assessing the type of phenolic acid mixture in the solution, as well as the concentration of presented phenolic acid compounds in the solution, with the help of additional concentration experiments.

34 Carbohydrates & Nutritional Quality of Hulled Wheats

P.I.: S. Simsek

Researcher: Jayani Kulathunga, PhD student

Collaborator: B. Reuhs

Objectives: The objective of this project was to identify variations in dietary fiber and starch fractions in flour and bread from hulled wheat, an underutilized ancient grain with potential health benefits.

Progress: Ten genotypes were characterized from three different hulled wheat species grown at Carrington, North Dakota: einkorn, emmer and spelt. Hard red spring (HRS) wheat flour was used for comparison to the hulled wheat samples. Samples were cleaned, dehulled, and milled. Bread was prepared according to AACCI method 10-09.01. Fluorescence-labelled images showed high β-glucan levels in HRS wheat and spelt. For spelt, β- glucan was localized only in the aleurone and sub aleurone layer, whereas it was detected most in the endosperm layer in common bread wheat. β-glucan was detected in aleurone, sub aleurone and endosperm cell walls of Einkorn and emmer. Arabinoxylans were detected in the pericarp of spelt and HRS, while minimal content was observed in pericarp of einkorn and emmer. Arabinoxylans were also detected in the aleurone of emmer and the endosperm of einkorn.

Arabinoxylan content and arabinan/xylan ratio from gas chromatography varied from 1.64 – 2.09% and 0.64 – 0.75, respectively. Contents and ratios varied among genotypes of einkorn and HRS but not spelt. Einkorn genotypes had higher relative contents of soluble and low-molecular weight fiber, such as raffinose, stachyose, fructo- and galacto-oligosaccharides, when compared to HRS. These results indicate that einkorn can be used as a potential candidate for breeding and as a prebiotic source in novel food products. Most interestingly, einkorn flours and breads contained greater contents of soluble fiber. Soluble fiber content was relatively greater among breads, which could be due to the conversion of insoluble fiber to soluble fiber and damage to fructans during heating. Using Englyst assay, rapidly digestible starch content of hulled wheat breads were all found to be lower relative to total starch content when compared to HRS. Greater slowly digestible starch content was reported in hulled wheats, following the order einkorn > spelt > emmer > HRS. Resistant starch content was not significantly different. Hydrolysis Index and estimated Glycemic Index were also greater for hulled wheat breads, following the same trend of emmer > einkorn > spelt > HRS. This could not be directly attributed to differences in slowly digestible starch content but could be related to different ratios in amylose and amylopectin.

35 Value Adding Strategy for Nut-Byproducts in Starch-Based Biodegradable Packaging Material

P.I.: S. Simsek

Researcher: Marcos Leon-Bejarano, MS student

Collaborator: M. Ovando-Martinez (University of Sonora, Mexico)

Objectives: The objectives of this project were to: 1) prepare biodegradable films from modified starches from octenyl succinate starch; 2) develop a value adding strategy to utilize waste streams from the nut processing industry by utilizing phenolic extracts from hazelnut skin (HSE) and pecan nut shells (PSE) to give antimicrobial properties to starch based films.

Progress: Films were prepared from octenyl-succinylated starch and HSE or PSE. The film's thickness varied from 0.087 mm to 0.091 mm. Solubility of films in water decreased from 20.3% to 17-18% after addition of up to 0.1% PSE or HSE. Contact angle of water droplets on the films gradually increased with added PSE or HSE. Neither extracts altered the water vapor permeability of OSS films. The OSS film was colorless, and both extracts imparted color to the films. Puncture and tear resistance decreased with addition of PSE, indicating plasticization, while both extracts decreased tensile strength. After 146 days in soil, biodegradation of OSS film decreased from 81% to 71% or less with addition of extracts. Surface and cross-section micrographs of OSS films showed that the extracts were evenly dispersed throughout the films. Preliminary findings showed absorption of UV light and indicate capability as a UV-barrier. Due to the antioxidant and antimicrobial properties of the phenolic compounds, these films should be evaluated using these properties against food spoilage, microorganisms, or pathogens of medical relevance to extend the application area of these films. The addition of HSE or PSE to the OSS films improved their UV light barrier property, and this was demonstrated by the UV-vis absorption spectra.

36 Molecular Rotor-based Characterization of Biopolymers in Emulsions

P.I.: Y. Yao

Researcher: Jingfan Chen, PhD student

Objectives: To advance the MR-based methodology as a new method to characterize emulsions

Progress: When biopolymers are used as emulsifiers to stabilize emulsions, the location and distribution of biopolymer molecules at the oil-water interface affects the overall quality of emulsions. On the other hand, the stability of emulsion also affects the distribution of biopolymers. Through the signals of fluorescence emission, the molecular rotor CCVJ has the capability to differentiate the performance of biopolymers at oil-water interface and sense the distribution of biopolymer molecules. In this project, the impact on CCVJ emission signals by different biopolymers (modified starch, gum arabic, or sodium caseinate), biopolymer concentrations, and oil-to-biopolymer ratios have been studied.

37 OHPP to Improve the Bioavailability of Niclosamide, a Potential COVID-19 Therapeutic

P.I.: Y. Yao (and collaborators)

Researcher: Zhuoran Chen, Intern

Objective: To improve the bioavailability of niclosamide

Progress: Niclosamide is an approved drug to treat tapeworms for both humans and animals. Studies have shown that niclosamide is also a highly potent antiviral compound against several viruses, including SARS-CoV-2, the virus that causes COVID-19. The major disadvantage of niclosamide, however, is its extremely low water solubility that leads to low bioaccessibility and bioavailability, which prohibits its effective use as an antiviral drug. To address this problem, we have applied a plant-based drug solubilizer octenylsuccinate hydroxypropyl phytoglycogen (OHPP) to increase the solubility of niclosamide and thus to increase its bioavailability.

Publications and Other Scholarly Activities

A. Papers, Books, Chapters, and Patent Applications Published

BeMiller, J.N.

1. **BeMiller, J.N.** (2020). Resistant starch. Chap. 7 In Welti-Chanes, S.O., Serna-Saldivar, Campanella, O., & Tejada-Ortigoza, V. (eds.), *Science and Technology of Fibers in Food Systems,* Springer (Springer Nature Switzerland), Cham, Switzerland.

2. **Fang, F.,** Luo, X., **BeMiller, J.N.,** Schaffter, S., **Hayes, A.M.R., Woodbury, T.J., Hamaker, B.R.,** & **Campanella, O.H.** (2020). Neutral hydrocolloids promote shear-induced elasticity and gel strength of gelatinized waxy potato starch. *Food Hydrocolloids, 107,* 105923.

3. Hsieh, C.-F., **BeMiller, J.N.,** & Huber, K.C. (2020). Impact of granule hydration on maize and wheat starch chemical reactivity at the granular and molecular levels. *Food Hydrocolloids, 100,* 105374.

4. **Zhuang, H., Feng, T.,** & **BeMiller, J.N.** (2019). Effects of hydrocolloids on normal maize starch and its distarch phosphates. *Food Hydrocolloids, 96,* 231-245.

5. **Zhuang, H., Feng, T.,** & **BeMiller, J.N.** (2020). Effects of hydrocolloids on waxy maize starch and its distarch phosphates. *Food Hydrocolloids, 100,* 105325.

See paper in Campanella (Xu et al.)

Campanella, O.H.

6. **Campanella, O.H.** & Tejada-Ortigoza (2020). Extraction and modifications of dietary fibers. functional properties in industrial applications. In Science and Technology of Fibers in Food Systems. Eds. Welti-Chanes, J.; Serna-Saldívar, S.O.; **Campanella, O.H.;** Tejada-Ortigoza, V. Springer Nature, New York.

7. Duizer, L., West, R. & **Campanella, O.H.** (2020). Fiber addition to cereal based foods: effects on sensory properties. In Science and Technology of Fibers in Food Systems. Eds. Welti-Chanes, J.; Serna-Saldívar, S.O.; **Campanella, O.H.**; Tejada-Ortigoza, V. Springer Nature, New York.

8. **Fang, F.,** Luo, X., **BeMiller, J.N.,** Schaffter, S., Hayes, A.M., **Woodbury, T.J., Hamaker, B.R**. & **Campanella, O.H.** (2020). Neutral hydrocolloids promote shear-induced elasticity and gel strength of gelatinized waxy potato starch. *Food Hydrocolloids,* 105923.

9. **Fang, F.**, Luo, X., Fei, X., Mathews, M., **Lim, J., Hamaker, B.R.,** & **Campanella, O.H.** (2020). A stored gelatinized waxy potato starch forms a strong retrograded gel at low pH with formation of intermolecular double helices. *Journal of Agricultural and Food Chemistry,* 68(13), 4036-4041.

10. Favaro-Trindade, C.S., Patel, B., Silva, M.P., Comunian, T.A., **Federici, E., Jones, O.G.,** & **Campanella, O.H.** (2020). Microencapsulation as a tool to producing an extruded functional food. *LWT, Food Science and Technology* 109433.

11. Fei, X., **Jones, O.G., Reuhs, B.L.,** & **Campanella, O.H.** (2020). Soluble pectin acts as a particle stabilizer of tomato suspensions: The impact on tomato products rheological characterization. *LWT, Food Science and Technology,* 110508.

12. Fevzioglu, M., **Ozturk, O.K., Hamaker, B.R.,** & **Campanella, O.H.** (2020). Quantitative approach to study secondary structure of proteins by FT-IR spectroscopy, using a model wheat gluten system. *International Journal of Biological Macromolecules, 164,* 2753-2760.

13. He, Y., Chen, F., Shi, Y., Guan, Z., Zhang, N., & **Campanella, O.H.** (2020). Physico-chemical properties and structure of rice cultivars grown in Heilongjiang Province of China. *Food Science and Human Wellness, 10,* 45-53

14. Kim, W.J., **Campanella, O.H.,** & Heldman, D.R. (2020). Predicting the performance of direct contact membrane distillation (DCMD): Mathematical determination of appropriate tortuosity based on porosity. *Journal of Food Engineering,* 110400.

15. Mendes-Oliveira, G., Deering, A.J., San Martin-Gonzalez, M.F. & **Campanella, O.H.** (2020). Microwave pasteurization of apple juice: Modeling the inactivation of Escherichia coli O157:H7 and Salmonella Typhimurium at 80-90 C. *Food Microbiology, 87,* 103382.

16. Mendes-Oliveira, G., Jin, T.Z., & **Campanella, O.H.** (2020). Modeling the inactivation of Escherichia coli O157: H7 and Salmonella Typhimurium in juices by pulsed electric fields: the role of the energy density. *Journal of Food Engineering, 282,* 110001.

17. Park, C., **Campanella, O.H.** and Maleky, F. (2020). Use of fractal analysis to characterize the structure of whey protein colloidal gels. *Journal of the American Oil Chemists' Society, 97,* 1, Sp. Iss., 39-40.

18. Spotti, M.J. & **Campanella, O.H.** (2020). Enzymatic processes of dietary fibers. In Science and Technology of Fibers in Food Systems, Eds. Welti-Chanes, J.; Serna-Saldívar, S.O.; **Campanella, O.H.;** Tejada-Ortigoza, V. Springer Nature, New York.

19. Tarhan, O. & **Campanella, O.H.** (2020). Microstructure and rheology of whey protein-based hydrogels. *Hacettepe Journal of Biology and Chemistry, 48,* 301-307.

20. **Tejada-Ortigoza, V.**, Welti-Chanes, J., **Campanella, O.H.**, & Peleg, M. (2020). Estimating equilibrium moisture content from relatively short sorption experiments. *LWT, Food Science and Technology, 132,* 109832.

21. Teng, C., **Chen, D.**, Wu, G., & **Campanella, O.H.** (2020). Non-invasive techniques to study starch structure and starchy products properties. *Current Opinion in Food Science, 38,* 196-202.

22. Welti-Chanes, J.; Serna-Saldívar, S.O.; **Campanella, O.H.** and Tejada-Ortigoza, V. (2020). Science and technology of fibers in food systems. In Food Engineering Series, ISBN 978-3-030-38653-5. Springer Nature, New York.

23. Xu, E., **Campanella, O.H.**, Ye, X., Jin, Z., Liu, D., & **BeMiller, J.N.** (2020). Advances in conversion of natural biopolymers: A reactive extrusion (REX)–enzyme-combined strategy for starch/protein-based food processing. *Trends in Food Science & Technology, 99,* 167-180.

See papers in Hamaker (Erickson et al., Fang et al., Fang et al.)
See paper in Ferruzzi (N'diaye et al.)
See papers in Jones (Castana et al., Chen et al., Chen et al., Federici et al., Federici et al.)
See paper in Narsimhan (Desam et al., Ponrajan et al.)

Ferruzzi, M.G.

24. Armah, S., **Ferruzzi, M.G.**, & Gletsu-Miller, N. (2020). Feasibility of mass-spectrometry to lower cost and blood volume requirements for assessment of B vitamins in patients undergoing bariatric surgery. *Metabolites, 10,* 240.

25. Chung, M., Zhao, N., Wang, D., Shams-White, M., Karlsen, M., Cassidy, A., **Ferruzzi, M, G.,** Jacques, P.F., Johnson, E.J., & Wallace, T.C. (2020). Dose–response relation between tea consumption and risk of cardiovascular disease and all-cause mortality: a systematic review and meta-analysis of population-based studies. *Advances in Nutrition, 11,* 790-814.

26. **Cladis, D.P.,** Weaver, C.M., & **Ferruzzi, M.G.** (2020). Polyphenol metabolism: a primer for practitioners. *Nutrition Today,* 55(5), 234-243.

27. **Cladis, D.P., Debelo, H.,** Lachcik, P.J., **Ferruzzi, M.G.**, & Weaver, C.M. (2020). Increasing doses of blueberry polyphenols alters colonic metabolism and calcium absorption in ovariectomized rats. *Molecular Nutrition and Food Research, 64,* 2000031.

28. **Cladis, D.P.,** Li, S., **Reddavari, L.,** Cox, A., **Ferruzzi, M.G.**, & Weaver, C.M. (2020). A 90 day oral toxicity study of blueberry polyphenols in ovariectomized Sprague-Dawley rats. *Food and Chemical Toxicology, 9,* 111254.

29. **Debelo, H., Li, M.**, & **Ferruzzi, M.G.** (2020). Processing influences on food polyphenol profiles and biological activity. *Current Opinions in Food Science, 32,* 90-102.

30. **Ferruzzi, M.G.,** Kruger, J., Mohamedshah, Z., **Debelo, H.,** & Taylor, J.R.N. (2020). Insights from in vitro exploration of factors influencing iron, zinc and provitamin A carotenoid bioaccessibility and intestinal absorption from cereals. *Journal of Cereal Chemistry, 96,* 103126.

31. **Ferruzzi, M.G., Hamaker, B.R.,** & Bordenave, N. (2020). Phenolic compounds are less degraded in presence of starch than in presence of proteins through processing in model porridges. *Food Chemistry, 309,* 125769.

32. Hayes, M. & **Ferruzzi, M.G.** (2020). Update on the bioavailability and chemopreventative mechanisms of dietary chlorophyll derivatives. *Nutrition Research, 81,* 19-37.

33. Hayes, M., Pottorff, M., Kay, C., Van Deynze, A., Osorio-Marin, J., Lila, M.A., Iorrizo, M., & **Ferruzzi, M.G.** (2020). In vitro bioaccessibility of carotenoids and chlorophylls in a diverse collection of spinach accessions and commercial cultivars. *Journal of Agricultural and Food Chemistry, 68,* 3495-3505.

34. Ho, K.K.H.Y., & **Ferruzzi, M.G.** (2020). Potential health benefits of polyphenols derived from fruit and 100% fruit juice. *Nutrition Reviews, 78,* 145-174.

35. Igho-Osagie, E., Cara, K., Wang, D., Yao, Q., Penkert, L.P., Cassidy, A., **Ferruzzi, M.G.,** Jacques, P.F., Johnson, E.J., Chung, M., Wallace, T. (2020). Effects of tea consumption on cardiovascular disease risks – a systematic review and meta-analysis. *Journal of Nutrition, 150,* 3269-3279.

36. Iorizzo, M., Curaba, J., Pottorff, M., **Ferruzzi, M.G.,** Simon, P., & Cavagnaro, P. (2020). Carrot anthocyanins and genetics: status and perspectives to improve its application for the food colorant industry. *Genes, 11,* 906.

37. Kruger, J., Taylor, J.R.N., **Ferruzzi, M.G.**, & **Debelo, H.** (2020). What is food-to-food fortification? A working definition and framework for evaluation of efficiency and implementation of best practices. *Comprehensive Reviews in Food Science and Food Safety, 19,* 3618-3658.

38. **Li, M.**, Corbin, S., Griffin, L., Neilson, A.P., & **Ferruzzi, M.G.** (2020). Modulating phenolic bioaccessibility and glycemic response in rats from starch-based food models by physical complexation between starch and phenolic acid. *Journal of Agricultural and Food Chemistry, 68,* 13257-13266.

39. **Li, M.**, **Ndiaye, C.**, Corbin, S., Foegeding, E.A., & **Ferruzzi, M.G.** (2020). Starch-phenolic complexes are built on physical CH-π interactions and can persist after hydrothermal treatments altering hydrodynamic radius and digestibility of model starch-based foods. *Food Chemistry, 308,* 125577.

40. Mengist, M., Burtch, H., **Debelo, H.,** Pottorff, M., Bostan, H., Nunn, C., Corbin, S., Kay, C.D., Bassil, N., Hummer, K., Lila, M.A., **Ferruzzi, M.G.,** Iorrizo, M. (2020). Development of a genetic framework to improve the efficiency of bioactive delivery from blueberry. *Scientific Reports, 10,* 1-13.

41. Moser, S., Shin, J-E., Kasturi, P., **Hamaker, B.R., Ferruzzi, M.G.,** & Bordenave, N. (2020). Formulation of orange juice with dietary fibers enhances bioaccessibility of orange flavonoids in juice but limits their ability to inhibit in vitro glucose transport. *Journal of Agricultural and Food Chemistry, 68,* 9387-9397.

42. **N'diaye, C., Martinez, M.M., Hamaker, B.R., Campanella, O.H.,** & **Ferruzzi, M.G.** (2020). Effect of edible plant materials on provitamin A stability and bioaccessibility from extruded whole pearl millet (P. typhoides) composite blends. *LWT – Food Science and Technology, 123,* 109109.

43. Sato, A., Pellegrini, G., Cregor, M., McAndrews, K., Choi, R., Maiz, M., Johnson, O., McCabe, L., McCabe, G., **Ferruzzi, M.G.,** Lila, M., Peacock, M., Burr, D., Nakatsu, C., Weaver, C., Bellido, T. (2020). Skeletal protection and promotion of microbiome diversity by dietary boosting of the endogenous antioxidant system. *Journal of Bone Mineral Research,* online.

44. Solverson, P.M., Henderson, T.R., **Debelo, H., Ferruzzi, M.G.,** Baer, D.J., & Novotny, J.A. (2020). An anthocyanin-rich mixed-berry intervention may improve insulin sensitivity in a randomized trial of overweight and obese adults. *Nutrients, 11,* 2876.

45. Sorkin, B.C., Kuszak, A.J., Fukagawa, N.K., Hoffman, F.A., Jafri, M., Barrett, B., Brown, P.N., Bushman, F.D., Casper, S., Chilton, F.H., Coffey, C.S., **Ferruzzi, M.G.,** Hopp, D.C., Kiely, M., Lakens, D., MacMillen, J.B., Meltzer, D., Pahor, M., Paul, J., Pritchett-Corning, K., Quinney, S., Rehermann, B., Stechell, K.D.R., Sipes, N., Stephens, J.M., Taylor, D.L., Tiriac, H., Walters, M., Xi, D., Zappala, G., & Pauli, G. (2020). Improving natural product research translation: from source to clinical trial. *The FASEB Journal, 34,* 41-65.

See paper in Hamaker (DeGroote et al.)

Hamaker, B.R.

46. **Ayua, E.O., Kazem, A.E.,** & **Hamaker, B.R.** (2020). Whole grain cereal fibers and their support of the gut commensal Clostridia for health. *Bioactive Carbohydrates and Dietary Fibre, 24,* 100245.

47. Bishehsari, F., Engen, P.A., Voigt, R.M., Swanson, G., Shaikh, M., Wilber, S., Naqib, A., Green, S.J., Shetuni, B., Forsyth, C.B., Saadalla, A., Osman, A., **Hamaker, B.R.**, Keshavarzian, A., & Khazaie, K. (2020). Abnormal eating patterns cause circadian disruption and promote alcohol-associated colon carcinogenesis. *Cellular and Molecular Gastroenterology and Hepatology, 9*, 219–237.

48. Burgess, H.J., Williams, B., Landay, A., Engen, P., Raeisi, S., Naqib, A., Fogg, L.L., Keshavarzian, A., Rasmussen, H.E., Zhang, X., **Hamaker, B.**, & Green, S.J. (2020). Sleep health should be included as a therapeutic target in the treatment of HIV. *AIDS Research and Human Retroviruses, 36*, 631-631.

49. **Cantu-Jungles, T.M.,** & **Hamaker, B.R.** (2020). New view on dietary fiber selection for predictable shifts in gut microbiota. *mBio, 11*, e02179-19.

50. De Groote, H., Mugalavai, V., **Ferruzzi, M.G.,** Onkware, A., Ayua, E., Duodu, K.G., Ndegwa, M., & **Hamaker, B.R.** (2020). Consumer acceptance and willingness to pay for instant cereal products with food-to-food fortification in Eldoret, Kenya. *Food and Nutrition Bulletin, 41*, 224–243.

51. Engen, P.A., Zaferiou, A., Rasmussen, H., Naqib, A., Green, S.J., Fogg, L.F., Forsyth, C.B., Raeisi, S., **Hamaker, B.**, & Keshavarzian, A. (2020). Single-arm, non-randomized, time series, single-subject study of fecal microbiota transplantation in multiple sclerosis. *Frontiers in Neurology, 11*.

52. Erickson, D.P., **Ozturk, O.K.,** Selling, G., Chen, F., **Campanella, O.H.,** & **Hamaker, B.R.** (2020). Corn zein undergoes conformational changes to higher β-sheet content during its self-assembly in an increasingly hydrophilic solvent. *International Journal of Biological Macromolecules, 157*, 232–239.

53. **Fang, F., Hayes, A.M.R.,** Watanabe, H., Higashiyama, T., **Campanella, O.H.,** & **Hamaker, B.R.** (2020). Isomaltodextrin strengthens model starch gels and moderately promotes starch retrogradation. *International Journal of Food Science and Technology, 56*, 1631-1640.

54. **Fang, F., Martinez, M.M., Campanella, O.H.,** & **Hamaker, B.R.** (2020). Long-term low shear-induced highly viscous waxy potato starch gel formed through intermolecular double helices. *Carbohydrate Polymers, 232*, 115815.

55. Gangoiti, J., **Corwin, S.G.**, Lamothe, L.M., Vafiadi, C., **Hamaker, B.R.**, & Dijkhuizen, L. (2020). Synthesis of novel α-glucans with potential health benefits through controlled glucose release in the human gastrointestinal tract. *Critical Reviews in Food Science and Nutrition, 60*, 123-146.

56. Glowacki, R.W.P., Pudlo, N.A., Tuncil, Y., Luis, A.S., Sajjakulnukit, P., Terekov, A.I., Lyssiotis, C.A., **Hamaker, B.R.**, & Martens, E.C. (2020). A ribose-scavenging system confers colonization fitness on the human gut symbiont *Bacteroides thetaiotaomicron* in a diet-specific manner. *Cell Host and Microbe, 27*, 79–92.e9.

57. **Gu, F.**, Li, C., **Hamaker, B. R.,** Gilbert, R. G., & **Zhang, X**. (2020). Fecal microbiota responses to rice RS3 are specific to amylose molecular structure. *Carbohydrate Polymers, 243*, 116475.

58. **Hamaker, B.R., Cantu-Jungles, T.M.** (2020). Discrete fiber structures dictate human gut bacteria outcomes. *Trends in Endocrinology & Metabolism, 31,* 803-805.

59. **Hasek, L.Y.**, Avery, S.E., Chacko, S.K., Fraley, J.K., Vohra, F.A., Quezada-Calvillo, R., Nichols, B.L., **Hamaker, B.R.** (2020). Conditioning with slowly digestible starch diets in mice reduces jejunal α-glucosidase activity and glucogenesis from a digestible starch feeding. *Nutrition, 78*, 110857.

60. **Hasek, L.Y.**, Phillips, R. J., Hayes, A.M.R., Kinzig, K.P., Zhang, G., Powley, T.L., & **Hamaker, B.R.** (2020). Carbohydrates designed with different digestion rates modulate gastric emptying response in rats. *International Journal of Food Sciences and Nutrition, 71*, 839–844.

61. **Hayes, A.M.R.,** Okoniewska, M., **Martinez, M.M.,** Zhao, B., & **Hamaker, B.R.** (2020). Investigating the potential of slow-retrograding starches to reduce staling in soft savory bread and sweet cake model systems. *Food Research International, 138*, 109745.

62. **Hayes, A.**, Gozzi, F., **Diatta, A.**, Gorrissen, T., Swackhamer, C., Bellmann, S., & **Hamaker, B.R.** (2020). Some pearl millet-based foods show potential to promote satiety and reduce glycemic response in humans. *British Journal of Nutrition, 1-31*.

63. **Hayes, A.M.R.,** Swackhamer, C., Mennah-Govela, Y.A., **Martinez, M.M., Diatta, A.,** Bornhorst, G.M., & **Hamaker, B.R.** (2020). Pearl millet (Pennisetum glaucum) couscous breaks down faster than wheat couscous in the Human Gastric Simulator, though has slower starch hydrolysis. *Food & Function, 11,* 111–122.

64. Nguyen, N.K., Deehan, E.C., Zhang, Z. Jin, M., Baskota, N., Perez-Muñoz, M.E., Cole, J., **Tuncil, Y.E.,** Seethaler, B., Wang, T., Laville, M., Delzenne, N.M., Bischoff, S.C., **Hamaker, B.R.**, Martínez, I., Knights, D., Bakal, J.A., Prado, C.M., Walter, J. (2020). Gut microbiota modulation with long-chain corn bran arabinoxylan in adults with overweight and obesity is linked to an individualized temporal increase in fecal propionate. *Microbiome, 8,* 1-21.

65. Te Poele, E.M., **Corwin, S.G., Hamaker, B.R.,** Lamothe, L.M., Vafiadi, C., & Dijkhuizen, L. (2020). Development of slowly digestible starch derivedα-glucans with 4,6-α- glucanotransferase and branching sucrase enzymes. *Journal of Agricultural and Food Chemistry, 68*, 6664–6671.

See papers in Campanella (Fang et al., Fang et al., Fevzioglu et al.)
See papers in Ferruzzi (Ferruzzi et al., Moser et al., N'diaye et al.)
See papers in Lindemann (Thakkar et al., Tuncil et al.)
See paper in Martinez (Roman et al.)

Jones, O.G.

66. Castanha, N., Miano, A.C., **Jones, O.G., Reuhs, B.L., Campanella, O.H.,** & Augusto, P. E. (2020). Starch modification by ozone: correlating molecular structure and gel properties in different starch sources. *Food Hydrocolloids,* 106027.

67. Chen, D., Fang, F., Federici, E., **Campanella, O.H.,** & **Jones, O.G**. (2020). Rheology, microstructure and phase behavior of potato starch-protein fibril mixed gel. *Carbohydrate Polymers*, 116247.

68. Chen, D., Narayanan, N., **Federici, E.,** Yang, Z., Zuo, X., Gao, J., Fang, F., Deng, M., **Campanella, O.H.**, **Jones, O.G.** (2020). Electrospinning induced orientation of protein fibrils. *Biomacromolecules*, *21*(7), 2772–2785.

69. **Federici, E., Jones, O.G**., Selling, G.W., Tagliasco, M., & **Campanella, O.H.** (2020). Effect of zein extrusion and starch type on the rheological behavior of gluten-free dough. *Journal of Cereal Science, 91*, 102866.

70. **Federici, E.**, Selling, G.W., **Campanella, O.H.,** & **Jones, O.G.** (2020). Incorporation of Plasticizers and co-proteins in zein electrospun fibers. *Journal of Agricultural and Food Chemistry*.

71. **Chen, D., Fang, F., Federici, E., Campanella, O.H.,** & **Jones, O.G.** (2020). Rheology, microstructure and phase behavior of potato starch-protein fibril mixed gel. *Carbohydrate Polymers, 239*, 116247.

72. Narayanan, N., Jiang, C., Wang, C., Uzunalli, G., Whittern, N., **Chen, D., Jones, O.G.**, Kuan, S., Deng, M. (2020). Harnessing fiber diameter-dependent effects of myoblasts toward biomimetic scaffold-based skeletal muscle regeneration. *Frontiers in Bioengineering and Biotechnology, 8*, 203.

See papers in Campanella (Favaro-Trindade et al., Federici et al., Fei et al.)
See paper in Narsimhan (Desam et al.)

Kokini, J.L.

73. **Bonilla, J., Erturk, M.Y.,** & **Kokini, J.L.,** (2020). Understanding the role of gluten subunits (LMW, HMW glutenins and gliadin) in the networking behavior of a weak soft wheat dough and a strong semolina wheat flour dough and the relationship with linear and non-linear rheology. *Food Hydrocolloids, 108*, 106002.

74. **Bonilla, J., Erturk, M.Y.,** Schaber, J.A., & **Kokini, J.L.** (2020). Distribution and function of LMW glutenins, HMW glutenins, and gliadins in wheat doughs analyzed with 'in situ' detection and quantitative imaging techniques. *Journal of Cereal Science, 93,* 102931.

75. **Helmick, H.,** & **Kokini, J.L.** (2020). Impact of ethanol, succinic acid, and the combination thereof at levels produced during sponge fermentation on hard wheat, soft wheat, and durum wheat farinograph rheology. *Journal of Cereal Science, 96*, 103082.

76. **Ma, X., Turasan, H.,** Jia, F., Seo, S., Wang, Z., Liu, G.L., **Kokini, J.L.** (2020). A novel biodegradable ESERS (enhanced SERS) platform with deposition

of Au, Ag and Au/Ag nanoparticles on gold coated zein nanophotonic structures for the detection of food analytes. *Vibrational Spectroscopy, 106,* 103013.

77. **Rouf, T.B.**, Díaz-Amaya, S., Stanciu, L., & **Kokini, J.L.** (2020). Application of corn zein as an anchoring molecule in a carbon nanotube enhanced electrochemical sensor for the detection of gliadin. *Food Control*, 107350.

78. **Turasan, H., Bonilla, J.,** Bozkurt, F., Maldonado, L., Li, X., Yilmaz, T., Sadeghi, R. (2020). Comparison of the fabrication methods, formation dynamics, structure and delivery performance of solid nanoparticles and hollow layer-by-layer (LbL) edible/biodegradable nanodelivery systems. *Journal of Food Process Engineering*. *43*, e13413.

79. **Turasan, H.**, & **Kokini, J.L.** (2020). Enhancing the bioavailability of nutrients by nano-delivery systems. In Food Nanotechnology: Applications and Approaches. Jafari, S.M. (Editor). Elsevier, pp. 345-375.

80. **Turasan, H.**, & **Kokini, J.L.** (2020). Delivery of bioactives using biocompatible nanodelivery technologies. In Handbook of Functionalized Nanomaterials for Industrial Applications, Hussain, C.M. (editor). Elsevier, pp. 133-166.

81. **Turksoy, S., Erturk, M.Y., Bonilla, J.,** Turasan, H., **Kokini, J.L.,** 2020. Effect of aging at different temperatures on LAOS properties and secondary protein structure of hard wheat flour dough. *Journal of Cereal Science, 92,* 102926.

Lindemann, S.R.

82. Anderton, C.R., Mobberley, J.M., Cole, J.K., Nunez, J.R., Starke, R., Boaro, A.A., Yesiltepe, Y., Morton, B.R., Cory, A.B., Cardamone, H.C., Hofmockel, K.S., Lipton, M.S., Moran, J.J., Renslow, R.S., Fredrickson, J.K., & **Lindemann, S.R.** (2020). Nitrogen source governs community carbon metabolism in a model hypersaline benthic phototrophic biofilm. *mSystems,* (5), 00260–20.

83. Hillman, E.T., Kozik, A.J., Hooker, C.A., Burnett, J.L., Heo, Y., Kiesel, V.A., Nevins, C.J., Oshiro, J.M., Robins, M.M., **Thakkar, R.D.**, Wu, S.T., & **Lindemann, S.R.** (2020). Comparative genomics of the genus *Roseburia* reveals divergent biosynthetic pathways that may influence colonic competition among species. *Microbial Genomics,* 6.

84. **Lindemann, S.R.** (2020). A piece of the pie: engineering microbiomes by exploiting division of labor in complex polysaccharide consumption. *Current Opinion in Chemical Engineering, 30,* 122.

85. Madigan, M.T., Kempher, M.L., Bender, K.S., Jung, D.O., Sattley, W.M., **Lindemann, S.R.**, Konopka, A.E., Dohnalkova, A.C., & Fredrickson, J.K. (2021). A green sulfur bacterium from epsomitic hot lake, Washington, USA. *Canadian Journal of Microbiology*, 67.

86. Molki, B., Call, D.R., Ha, P.T., Omsland, A., Gang, D.R., **Lindemann, S.R.**, Killiny, N., & Beyenal, H. (2020). Growth of 'Candidatus Liberibacter asiaticus' in a host-free microbial culture is associated with microbial community composition. *Enzyme and Microbial Technology, 142,* 109691

87. Parois, S.P., Duttlinger, A.W., Richert, B.T., **Lindemann, S.R.,** Johnson, J.S., & Marchant-Forde, J.N. (2020). Effects of three distinct 2-week long diet strategies after transport on weaned pigs' short and long-term welfare markers, behaviors, and microbiota. *Frontiers in Veterinary Science*, 7.

88. **Thakkar, R.D., Tuncil, Y.E., Hamaker, B.R.,** & **Lindemann, S.R.** (2020). Maize bran particle size governs the community composition and metabolic output of human gut microbiota in *in vitro* fermentations. *Frontiers in Microbiology, 11,* 1009.

89. **Tuncil, Y.E., Thakkar, R.D., Arioglu-Tuncil, S., Hamaker, B.R.,** & **Lindemann, S.R.** (2020). Subtle variations in dietary-fiber fine structure differentially influence the composition and metabolic function of gut microbiota. *mSphere, 5,* e00180-20.

90. Wiese, G.N., Biruete, A., Moorthi, R.N., Moe, S.M., **Lindemann, S.R.**, & Hill Gallant, K.M. (2020). Plant-based diets, the gut microbiota, and trimethylamine n-oxide production in chronic kidney disease: therapeutic potential and methodological considerations. *Journal of Renal Nutrition*.

91. **Yao, T.**, Chen, M.-H., & **Lindemann, S.R.** (2020). Structurally complex carbohydrates maintain diversity in gut-derived microbial consortia under high dilution pressure. *FEMS Microbiology Ecology, 96,* fiaa158.

92. Xu, C., Couvillion, S.P., Sontag, R.L., Isern, N.G., Maezato, Y., **Lindemann, S. R.**, Roy Chowdhury, T., Zhao, R., Morton, B.R., Moore, R.J., Jansson, J.K., Bailey, V.L., Mouser, P.J., Romine, M.F., Fredrickson, J.F., & Metz, T.O. MetFish: A metabolomics platform for studying microbial communities in chemically extreme environments: supplemental section. *Cold Spring Harbor Laboratory*. doi: 10.1101/518647.

93. **Lindemann, S.R.**, Wright, A.T. "Chromatin Activity Precipitation Method and System." U.S. Patent (Approved: August 4, 2020).

Martinez, M.M.

94. Huang, S., Roman, L., **Martinez, M.M.**, Bohrer, B.M. (2020). Modification of physicochemical properties of breadfruit flour using different twin-screw extrusion conditions and its application in soy protein gels. *Foods, 9*, 1071.

95. **Martinez, M.M.** (2020). Starch nutritional quality: beyond intraluminal digestion in response to current trends. *Current Opinion in Food Science, 38,* 112-121.

96. Mora, C., Martinez-Alejo, J.M., Roman, L., **Martinez, M.M.**, Carvajal, T., Pinal, R., Mora-Huertas, C.E. (2020). Molecular and physical characterization of octenyl succinic anhydride-modified starches with potential applications in pharmaceutics. *International Journal of Pharmaceutics, 579,* 119163.

97. Park, R., Roman, L,. Falardeau, L., Albino, L., Joye, I., **Martinez, M.M.** (2020). High temperature rotational rheology of the seed flour to predict the texture of canned red kidney beans (Phaseolus vulgaris). *Foods, 9*, 1002.

98. Pico, J., Pismag, R.Y., Laudouze, M., **Martinez, M.M.** (2020). Systematic evaluation of the Folin-Ciocalteu and Fast Blue BB reactions during the analysis of total phenolics in legumes, nuts and plant seeds. *Food & Function, 11*, 9868-9880.

99. Rho, Y., Patterson, R., Joye, I., **Martinez, M.M.**, Squires, J.E., Kiarie, E. (2020). Fiber degrading enzyme increased monosaccharides release and fermentation in corn distillers dried grains with solubles and wheat middlings steeped without or with protease. *Translational Animal Science, 4*, txaa153.

100. Roman, L., Gomez, M., & **Martinez, M.M.** (2020). Mesoscale structuring of gluten-free bread with starch. *Current Opinion in Food Science*, online.

101. Roman, L., Guo, M., **Terekhov, A.,** Grossutti, M., Vidal, N. P., **Reuhs, B.L.,** & **Martinez, M.M.** (2020). Extraction and isolation of pectin rich in homogalacturonan domains from two cultivars of hawthorn berry (Crataegus pinnatifida). *Food Hydrocolloids, 113*, 106476.

102. Roman, L., Reguilon, M.P., Gomez, M., & **Martinez, M.M.** (2020). Intermediate length amylose increases the crumb hardness of rice flour gluten-free breads. *Food Hydrocolloids, 100,* 105451.

103. Roman, L., Reguilon, M., **Martinez, M.M.**, Gomez, M. (2020). The effects of starch cross-linking, stabilization and pre-gelatinization at reducing gluten-free bread staling. *LWT-Food Science and Technology*, *123*, 109109.

104. Roman, L., Yee, J., **Hayes, A.M.R., Hamaker, B.R.,** Bertoft, E., **Martinez, M.M.** (2020). On the role of the internal chain length distribution of amylopectins during retrogradation: double helix lateral aggregation and slow digestibility. *Carbohydrate Polymers, 246,* 116633.

105. Sharma, M., Pico, J., **Martinez, M.M.**, Duizer, L. (2020). The dynamics of starch hydrolysis and thickness perception during oral processing. *Food Research International*, 134, 109275.

106. Xu, K., Guo, M., Roman, L., Pico, J., **Martinez, M.M.** (2020). Okra seed and seedless pod: comparative study of their phenolics and carbohydrate fractions and their impact on bread-making. *Food Chemistry*, *317*, 126387.

107. Xu, K., **Martinez, M.M.**, Yang, B., Guo, M. (2020). Fine structure, physicochemical and antioxidant properties of LM-pectins from okra pods dried under different techniques. *Carbohydrate Polymers, 241,* 116272.

108. Yee, J., Roman, L., Pico, J., Aguirre-Cruz, A., Bello-Perez, L.A., Bertoft, E., **Martinez, M.M.** (2020). The molecular structure of starch from different Musa genotypes: higher branching density of amylose chains seems to promote enzyme-resistant structures. *Food Hydrocolloids, 112,* 106351.

See paper in Ferruzzi (N'diaye et al.)
See papers in Hamaker (Fang et al., Hayes et al., Hayes et al.)

Mauer, L.J.

109. **Allan, M.C.,** Chamberlain, M., & **Mauer, L.J.** (2020). Effects of sugars and sugar alcohols on the gelatinization temperatures of wheat, potato, and corn starches. *Foods, 9*.

110. **Allan, M.C., Grush, E.**, & **Mauer, L.J.** (2020). RH-temperature stability diagram of alpha- and beta- anhydrous and monohydrate lactose crystalline forms. *Food Research International, 127*.

111. **Allan, M.C.,** Owens, B., & **Mauer, L.J.** (2020). Relative humidity-temperature transition boundaries for anhydrous beta-caffeine and caffeine hydrate crystalline forms. *Journal of Food Science, 85,* 1815–1826.

112. **Arioglu-Tuncil, S., Voelker, A.L.**, Taylor, L.S., & **Mauer, L.J.** (2020). Amorphization of thiamine chloride hydrochloride: effects of physical state and polymer type on the chemical stability of thiamine in solid dispersions. *International Journal of Molecular Sciences, 21*.

113. **Arioglu-Tuncil, S., Voelker, A.L.,** Taylor, L.S., & **Mauer, L.J.** (2020). Amorphization of thiamine mononitrate: a study of crystallization inhibition and chemical stability of thiamine in thiamine mononitrate amorphous solid dispersions. *International Journal of Molecular Sciences, 21*.

114. Calzada-Luna, G., Sam Martin-Gonzalez, F., **Mauer, L.J.,** & Liceaga, A. (2020). Cricket (Acheta domesticus) protein hydrolysates' impact on the physicochemical, structural and sensory properties of tortillas and tortilla chips. *Journal of Insects as Food and Feed, 71,* 109–120.

115. Ismail, Y., & **Mauer, L.J.** (2020). Phase transitions of ascorbic acid and sodium ascorbate in a polymer matrix and effects on vitamin degradation. *Journal of Food Process Engineering, 43*.

116. Liceaga, A.M., Calzada-Luna, G., San Martin-Gonzalez, M.F., & **Mauer, L.J.** (2020). Cricket (Acheta domesticus) protein hydrolysates impact on the physicochemical, structural and sensory properties of tortillas and tortilla chips. *Journal of Insects as Food and Feed,* 1-12.

117. Tongdeesoontorn, W., **Mauer, L.J.,** Wongruong, S., Sriburi, P., & Rachtanapun, P. (2020). Physical and antioxidant properties of cassava starch-carboxymethyl cellulose incorporated with quercetin and TBHQ as active food packaging. *Polymers, 12*.

118. **Voelker, A.L.,** Sommer, A.A., & **Mauer, L.J.** (2020). Moisture sorption behaviors, water activity- temperature relationships, and physical stability traits of spices, herbs, and seasoning blends containing crystalline and amorphous ingredients. *Food Research International, 136*.

119. **Woodbury, T.**, & **Mauer, L.J.** (2020). Oligosaccharide structures, functions and opportunities for use in reduced sugar applications. *The Manufacturing Confectioner, 100*, 27–37.

Narsimhan, G.N.

120. **Desam, G.P.,** Li, J., Chen, G., **Campanella, O.H.,** & **Narsimhan, G.N.** (2020). Swelling kinetics of rice and potato starch suspensions. *Journal of Food Process Engineering*, 43, e13353.

121. Ponrajan, A., Tonner, T., Okos, M., **Campanella, O.H.,** & **Narsimhan, G.N.** (2020). Comparing inline extrusion viscosity for different operating conditions to offline capillary viscosity measurements. *Journal of Food Process Engineering*, 43, e13199.

Reddivari, L.

122. Bao, Y., **Reddivari, L.,** & Huang, J.Y. (2020). Development of cold plasma pretreatment for improving phenolics extractability from tomato pomace. *Innovative Food Science & Emerging Technologies, 65,* 102445.

123. Bao, Y., **Reddivari, L.,** & Huang, J.Y. (2020). Enhancement of phenolic compounds extraction from grape pomace by high voltage atmospheric cold plasma. *LWT-Food Science and Technology, 133,* 109970.

124. Hall, F., **Reddivari, L,** & Liceaga, A.M. (2020). Identification and characterization of edible cricket peptides on hypertensive and glycemic in vitro inhibition and their anti-inflammatory activity on RAW 264.7 macrophage cells. *Nutrients, 12*, 3588.

125. Sidorov, E., Bejar, C., Xu, C., Ray, B., **Reddivari, L.,** Chainakul, J., Vanamala, J.K.P., & Sanghera, D.K. (2020). Potential metabolite biomarkers for acute versus chronic stage of ischemic stroke: A pilot study. *J Stroke Cerebrovascular Dis. 29*, 104618

126. Wu, B., Bhatnagar, R.S., Indukuri, V., Chopra, S., March, K., Cordero, N., Chopra, S., & **Reddivari, L.** (2020). Intestinal mucosal barrier function restoration in mice by maize diet containing enriched flavan-4-ols. *Nutrients, 12*, 896

127. Zinati, G., **Reddivari, L.,** & Lang, J. (2020). Organic management practices for Allium leafminer (ALM) pest. https://rodaleinstitute.org/science/articles/organic-management-allium-leafminer-pest/

See paper in Ferruzzi (Cladis et al.)

Reuhs, B.L.

See papers in Campanella (Castanha et al., Fei et al.)
See paper in Martinez (Roman et al.)
See paper in Simsek (Kulathunga et al.)

Simsek, S.

128. Alahmed, A., & **Simsek, S.** (2020). Pre-harvest glyphosate application effects on properties of β-glucan from oat groats. *Journal of Cereal Science, 96*, 103119.

129. Asiyanbi-Hammed, T.T., & **Simsek, S.** (2020). Quality and storage characteristics of hot press tortilla prepared from yam-wheat composite flour. *Food and Nutrition Sciences, 11*, 235-254.

130. Baasandorj, T., Ohm, J.B., Dykes, L., **Simsek, S.** (2020). Comparison of different experimental breadmaking methods and their associations with flour quality parameters in hard red spring wheat. *Cereal Chemistry. 97*, 515-526.

131. Chia, L., Blazanin, G., Huang, Y., Rashid, U.S., Lu, P., **Simsek, S.,** & N Bezbaruah, A. (2020). Surface treatment of carbon nanotubes using modified tapioca starch for improved force detection consistency in smart cementitious materials. *Sensors, 20*, 3985.

132. Fujita, A., **Simsek, S.,** & Schwarz, P.B. (2020). Observations on the malting of ancient wheats: einkorn, emmer and spelt. *Fermentation, 6*, 125.

133. Kulathunga, J., **Reuhs, B.L.,** & **Simsek, S.** (2020). A review: Novel trends in hulled wheat processing for value addition. *Trends in Food Science & Technology. 106*, 232-241

134. Leier, J., Daba, S., Friskop, A., Johnson, B., Rasmussen, J., **Simsek, S.,** & Green, A. (2020). Fusarium head blight resistance in F1 hybrid spring wheat. *Canadian Journal of Plant Pathology*. 1-9.

135. Leon-Bejarano, M., Durmus, Y., Ovando-Martínez, M., & **Simsek, S.** (2020). Physical, barrier, mechanical, and biodegradability properties of modified starch films with nut by-products extracts. *Foods, 9*, 226.

136. **Magallanes-Lopez, A.,** Manthey, F., **Simsek, S.** (2020). Wet milling of deoxynivalenol contaminated wheat: effect on physicochemical properties of starch. *Cereal Chemistry, 97*, 293-303.

137. Malalgoda, M., Ohm, J.B., Howatt, K.A., & **Simsek, S.** (2020). Pre-harvest glyphosate application and effects on wheat starch chemistry: analysis from application to harvest. *Journal of Food Biochemistry, 44*, e13330. (cover image)

138. Malalgoda, M., Ohm, J.B., Howatt, K.A., Green, A., & **Simsek, S.** (2020). Effects of pre-harvest glyphosate use on protein composition and shikimic acid accumulation in spring wheat. *Food Chemistry, 332*, 127422.

139. Malalgoda, M., Ohm, J.B., Ransom, J.K., Howatt, K., & **Simsek, S.** (2020). Effects of pre-harvest glyphosate application on spring wheat quality characteristics. *Agriculture, 10*, 111.

140. Nishitsuji, Y., Whitney, K., Nakamura, K., Hayakawa, K., & **Simsek, S.** (2020). Changes in structure and solubility of wheat arabinoxylan during the breadmaking process. *Food Hydrocolloids, 109*, 106129.

141. Qi, X., **Simsek, S.,** Chen, B., & Rao, J. (2020). Alginate-based double-network hydrogel improves the viability of encapsulated probiotics during simulated sequential gastrointestinal digestion: effect of biopolymer type and concentrations. *International Journal of Biological Macromolecules, 165*, 1675-1685.

142. Qi, X., **Simsek, S.,** Ohm, J.B., Chen, B., Rao, J. (2020). Viability of Lactobacillus rhamnosus GG microencapsulated in alginate/chitosan hydrogel particles during storage and simulated gastrointestinal digestion: role of chitosan molecular weight. *Soft Matter*. *16*(7):1877-1887

143. Rahman, M.M., & **Simsek, S.** (2020). Go clean label: replacement of commercial dough strengtheners with hard red spring wheat flour in bread formulations. *Journal of Food Science and Technology, 57,* 3581-3590.

144. **Simsek, S.** (2020). Clean-label bread: Using hard red spring wheat to replace dough improvers in whole wheat bread. *Journal of Food Processing and Preservation, 44,* e14920.

145. **Simsek, S.,** Budak, B., Schwebach, C., Ovando-Martínez, M. (2020). Starch digestibility properties of bread from hard red spring wheat cultivars released in the last 100 years. *Cereal Chemistry, 97,* 138-148.

146. Simsek, T., Rasulev, B., Mayer, C., & **Simsek, S.** (2020). Preparation and characterization of inclusion complexes of β-cyclodextrin and phenolics from wheat bran by combination of experimental and computational techniques. *Molecules, 25,* 4275.

147. Snelling, J., Malekmohammadi, S., Bergholz, T., Ohm, J.B., **Simsek, S.** (2020). Evaluation of vacuum steam treatment of Hard Red Spring Wheat on flour quality and reduction of Escherichia coli O121 and Salmonella Enteritidis PT30. *Journal of Food Protection. 83,* 836-843.

148. Vatansever, S., **Whitney, K.,** Ohm, J.B., **Simsek, S.,** & Hall, C. (2020). Physicochemical and multi-scale structural alterations of pea starch induced by supercritical carbon dioxide+ ethanol extraction. *Food Chemistry, 344,* 128699.

149. **Whitney, K.,** & **Simsek, S.** (2020). Potato flour as a functional ingredient in bread: evaluation of bread quality and starch characteristics. *International Journal of Food Science & Technology, 55,* 3639-3649.

Yao, Y.

150. **Fu, Y.**, Bhunia, A.K., & Yao, Y. (2020). Abrasive brushing reduces pathogen biofilms at cantaloupe rind surface. *International Journal of Food Microbiology, 32*.

151. **Peng, X.**, & **Yao, Y.** (2020). Molecular rotor as a structural probe of glucan polymers: amylopectin, phytoglycogen, and their beta-limit dextrins as models. *Carbohydrate Polymers, 250,* 116859.

152. **Xie, Y.**, & **Yao, Y.** (2020). Preparation and characterization of a solid dispersion containing curcumin and octenylsuccinate hydroxypropyl phytoglycogen for improved curcumin solubility. *European Journal of Pharmaceutical Sciences, 153,* 105462.

B. Papers Presented at Meetings, Conferences, and Invited Public Lectures

January

Campanella, O.H. Properties of food and biomaterials, a tool to design and optimize food processes. Whistler Center for Carbohydrate Research Webinar Series, West Lafayette, IN.

February

Mauer, L. Deliquescence and deliquescence lowering effects on product quality, Puratos, Belgium.

Lindemann, S.R. Fiber structure controls on the structure and function of gut microbiota. University of Nebraska, Lincoln, NE.

March

Cladis, D.P., Li, S., Reddivari, L., Cox, A., **Ferruzzi, M.G.,** Weaver, C.M. A 90d subchronic toxicity evaluation of blueberry polyphenols in ovariectomized Sprague-Dawley rats. Society of Toxicology, Anaheim, CA.

Guo, M., Roman, L., Xu, K., Lim, L., **Hamaker, B.R, Martinez, M.M.** Molecular structure, emulsifying and gelling ability of pectin extracted from different hawthorn varieties. 15th International Hydrocolloids Conference, Melbourne, Australia.

Hamaker, B.R. The importance of physical form of dietary fibers to a healthy gut microbiota. 15th International Hydrocolloids Conference, Melbourne, Australia.

Martinez, M.M, Lozano-Perez, H., Yee, J., Roman, L., Carvajal, T. The importance of surface attributes on bulk and functionality performance of starch granules. 15th International Hydrocolloids Conference, Melbourne, Australia.

Martinez, M.M. Shear-induced molecular fragmentation decreases the bioaccesibility of fully gelatinized starch and its gelling capacity. 71 Starch Convention of the Association of Cereal Research Association in cooperation with the Max Rubner Institute, Detmold, Germany.

Reddivari, L., Polyphenol-carbohydrate interactions: effects on functional properties. Whistler Center for Carbohydrate Research Webinar Series, West Lafayette, IN.

Wu, B., Chang, H., Chopra, S., **Reddivari. L.** Enhanced flavan-4-ols corn diet protects intestinal barrier function in mice. 62nd Annual Maize Genetics Meeting, Kailua-Kona, Hawaii.

May

Hamaker, B.R. Ideas on aligning dietary fiber structures to gut bacteria. Whistler Center for Carbohydrate Research 2020 Technical Conference, West Lafayette, IN.

Lindemann, S.R. Unraveling the connections between fiber structure and gut microbial species. Whistler Center for Carbohydrate Research 2020 Technical Conference, West Lafayette, IN.

Rho, Y., Patterson, R., Joye, I., **Martinez, M.M.,** Kiarie, E. Is there a synergic effect when corn distillers dried grains with solubles (DDGS) or wheat middlings (WM) are steeped with combination of carbohydrase and protease? 2020 Animal Nutrition Conference of Canada (ANCC), Winnipeg, Canada.

Martinez, M.M. Design of sustainable ingredients for healthy bakery products: matrix phenolic and carbohydrate fractions in relation to glycaemia. Whistler Center for Carbohydrate Research 2020 Technical Conference, West Lafayette, IN.

Reddivari, L. Anti-colitic effects of flavonoids: Role of gut bacteria. Whistler Center for Carbohydrate Research 2020 Technical Conference, West Lafayette, IN.

June

Hamaker, B.R. Starch digestibility and health, North Dakota State University.

Hamaker, B.R. Concept of tailoring fiber-based prebiotics for personalized gut health. Institute of Food Technologists Annual Meeting, Institute of Food Technologists.

Li, S., Wang, T., Xu, B., Indukuri, V., Vanamala, J.K.P., **Reddivari, L.** 2020. Anthocyanin-containing purple potatoes ameliorate DSS-induced colitis in mice. ASN Annual Meeting.

Martinez, M.M. Nano-enhancing the nutritional quality of fully gelatinized starch in baked goods. IFT 2020, Chicago, IL.

Martinez, M.M. Nano-enhancing the nutritional quality of fully gelatinized starch in baked goods. IFT 2020, Chicago, IL.

Martinez, M.M. The importance of rapid rheological indicators during heating/cooling cycles. Perkin Elmer, Online Workshop.

Reddivari, L., Li, S., Wang, T., Kennett, M., Vanamala, J.K.P. Role of gut microbiota in anti-colitic effects of color-fleshed potatoes. American Society of Nutrition Annual Meeting.

Wu, B., **Li, S.,** Chang, H, Anderson, R., Chopra, S., **Reddivari, L.** Maize flavan-4-ols and anthocyanins alleviated dextran sulfate sodium-induced colitis in mice via intestinal barrier function restoration. American Society of Nutrition Annual Meeting.

July

Jones, O.G. Food-relevant utility and stability of structures formed from corn storage protein. Institute of Food Technologists, Institute of Food Technologists 2020 Annual Meeting.

Lindemann, S.R. Making sense of microbiome data in food science. Whistler Center for Carbohydrate Research Webinar Series, West Lafayette, IN.

Martinez, M.M. Nano-enhancing carbohydrate streams for controlled glycaemia and delivery of phenolic compounds. Congreso Internacional Digital en Alimentos Funcionales y Nutracéuticos: 2020 Rumbo al 2021, Mexico.

Vatansever, S., Ohm, J.B., **Simsek, S.,** & Hall, C. Supercritical fluid extraction as a deodorization tool: Effect on pea protein isolate properties. Institute of Food Technologists 2020 Annual Meeting.

August

Bao, Y., **Reddivari. L.,** Huang, J.Y. Enhancement of phenolic compounds extraction from tomato pomace by high voltage atmospheric cold plasma. International Union of Food Science and Technology. Auckland, New Zealand.

Huang, S., Roman, L., **Martinez, M.M.,** Bohrer, B.M. Breadfruit flour engineered with different twin-screw extrusion conditions and the effects on physicochemical properties of flour and technological properties of meat emulsions. AMSA 2020 Reciprocal Meat Conference. Orlando, Florida.

Lindemann, S.R. Microbiota responses to dietary fiber structures are both highly individual and generalizable. American Chemical Society, American Chemical Society Fall 2020 National Meeting.

Martinez, M.M. Plenary inspirational lecture. 2020 PepsiCo Research Forum, Monterrey, Mexico.

September

Simsek, S. Pros and Cons of Dietary Fiber Analysis Methods: What do I measure with each method?" Whistler Center for Carbohydrate Research Webinar Series, West Lafayette, IN.

October

Dona, J.M., & **Simsek, S.** Baking and nutritional quality of bread made from whole grain hulled wheat. Cereals & Grains 20.

Hamaker, B.R. Fiber-based prebiotic potential for personalized gut health, Cereals & Grains 20.

Hamaker, B.R. Importance of plant fibers and diversity on the microbiome. Kellogg Co.

Lindemann, S.R. Making sense of microbiome data in food science. Kellogg Co.

López, A.M.M., Whitney, K., & **Simsek, S.** Starch bioavailability evaluation of dry bean varieties grown in North Dakota. Cereals & Grains 20.

Martinez, M.M. Prospective ingredients and molecular mechanisms to improve carbohydrate nutritional quality. General Mills

Ohm, J.B., **Simsek, S.,** Dykes, L., & Anderson, J.A. Influence of tempering condition on kernel crush-response profile and quality traits in hard red spring wheat. Cereals & Grains 20.

Whitney, K.L., & **Simsek, S.** Evaluation of whole wheat flour by GlutoPeak at varied speed profiles. Cereals & Grains 20.

November

Campanella, O.H. Protein extrusion, and material structure and texture. Archer Daniels Midland.

Campanella, O.H. Extrusion of high protein and high fiber ingredients challenges to improve the product attributes. PepsiCo.

Desam, G.P., Li, J., Narsimhan, V., & **Narsimhan, G.N.** Prediction of storage modulus during swelling of starch suspensions, American Institute of Chemical Engineers Annual Meeting.

Federici, E., **Jones, O.G.**, **Campanella, O.H.**, Selling, G.W. Zein thermal treatments to improve elasticity in gluten-free dough. Cereals & Grains 20.

Ferruzzi, M.G. Can phytochemical bioavailability be a genetically modifiable trait in fruits, vegetables and whole grains? Whistler Center for Carbohydrate Research Webinar Series, West Lafayette, IN.

Ferruzzi, M.G. Strategies for incorporation and stabilization of phytochemicals in food systems. PepsiCo.

Jones, O.G. Effects of structure and solution conditions on protein-starch interactions. Cereals and Grains, Cereals and Grains 2020 Annual Meeting.

Hamaker, B.R. Starch changes to affect digestion, PepsiCo Inc.

Hamaker, B.R. Towards designing healthier carbohydrate-based processed foods, Virginia Tech University.

Hamaker, B.R. Carbohydrates and health; Carbohydrates and texture. Hayashibara, Japan.

Lindemann, S.R. Fiber structure influences on the gut microbiome. PepsiCo Inc.

Lindemann, S.R. Fine structure drives. 4th Microbiome Movement - Human Nutrition Summit, Hanson Wade.

Martinez, M.M. Opportunities and challenges of plant-based foods in times of pandemics and environmental sustainability. XXXII AETC days, Spain.

Martinez, M.M. Upcycled polymeric plant waste to control body weight and prevent diabetes. Uni Food Day. Danish Food Innovation.

Mauer, L. Solid state characterization and effects of water thereon. Hayashibara, Japan.

Narsimhan, G.N. Potential for nano-emulsions for bioactive delivery systems. PepsiCo.

Simsek, S. Cereal & carbohydrate chemistry research at North Dakota State University:
A 360 Degree Research Approach. Hayashibara, Japan.

Weil, C.F. Phenotyping, high throughput screens and value-added traits systems. PepsiCo.

December

Erturk, M.Y., Kokini, J.L. The relationship between LAOS (Large Amplitude Oscillatory Shear) rheological characteristics of yogurt samples and protein network quantification with SEM imaging. ICR 2020 Symposium, Rio de Janerio, Brazil.

Hamaker, B.R. Prebiotic potential of grains, tubers, and pulses. PepsiCo Inc.

Hamaker, B.R. Towards designing healthier carbohydrate-based foods. Mars Wrigley.

Hayes, A.M.R. Dietary carbohydrate digestion, carbohydrate oxidation, and metabolic flexibility. SDC Special Seminar.

Lindemann, S.R., Carbohydrate structure influences on the gut microbiome. Mars Wrigley.

Lindemann, S.R. Fiber structure influences on the gut microbiome. Cargill.

Martinez, M.M. Snacking right: molecular mechanisms to improve carbohydrate nutritional quality. 4th International Symposium on Phytochemicals in Medicine and Food, Xi'an, China.

C. Graduate Degrees Awarded

Spring 2020

1. José Bonilla, PhD, Understanding the Mixing Dynamics and Structural Functionality of Gluten Subunits Tagged with Quantum Dots in Wheat Dough and Analyzed by Confocal Microscopy and Quantitative Imaging Techniques
2. Dennis Cladis, PhD, Consuming High Doses of Blueberry Polyphenols is Safe, but Induces Dose-Dependent Shifts in Metabolism
3. Jayani Maddakandage Dona Kulathunga, MS, Comparative Study on Hulled Wheats: Kernel, Flour, Dough Quality and Dietary Fiber Variation

Summer 2020

4. Sarah Corwin, PhD, Structural and Functional Properties of Enzymatically Modified Slow Digesting Alpha-Glucans
5. Hazal Turasan, PhD, Fabrication of Zein-Based Biodegradable Surface-Enhanced Raman Spectroscopy Biosensor Platforms for the Detection of Food Toxins

Fall 2020

6. Enosh Kazem, MS, Prebiotic Potential of a Wide Selection of Tubers, Grains, and Pulses Relative to Fructo-Oligosaccharide
7. Adrienne Voelker, PhD, Degradation Pathways of Thiamine and the Impact on Food Quality and Sensory Attributes

D. Recognitions, Awards, and Honors

James BeMiller
Dr. John Fannon, former PhD student, has willed a gift to establish the "Dr. James BeMiller Chair in Carbohydrate Science"

Sarah Corwin
College of Agriculture Graduate Spotlight, Summer 2020

Merve Yildirim Erturk
Society of Rheology Student Travel Grant
Purdue University Graduate School Travel Grant

Enrico Federici
ABE Purdue Industrial Research Symposium Biotechnology, Regulations, Food Processing, poster competition 1st place, February 2020

Bruce Hamaker
Corrine Alexander Spirit of the Land Grant Award, Purdue University College of Agriculture

Anna Hayes
IFT Carbohydrate Division, Outstanding Service Award, July 2020
Phi Tau Sigma Dr. Gideon 'Guy' Livingston Scholarship Recipient, July 2020

Harrison Helmick
Cereals and Grains Student Association, Chair
Institute of Food Technologist: Midwest Area Meeting/College Bowl Chair

Jayani (Maddakandage Dona) Kulathunga
Finalist for the Best Student Research Award in the Cereal and Grain Nutrition Division at the 2020 annual meeting of the Cereals and Grains Association

Ana Magallanes López
Best Relationship to the Theme in the Student Research Video Competition at the 2020 annual meeting of the Cereals and Grains Association

Finalist for the Best Student Research Award in the Cereal and Grain Nutrition Division at the 2020 annual meeting of the Cereals and Grains Association

Mario Martinez
Young Scientist Research Award. American Association of Cereal Chemists International (AACCI, now Cereals & Grains Association) for outstanding early-career contributions in cereal science research.

Cindy Mayorga
Purdue University Food Science Graduate Student Association, President

Adrianna Pilch
Purdue ARGE Fellowship, Fall 2020

Adam Quinn
Purdue ARGE Fellowship, Fall 2020

Monica Richmond
Purdue Lynn Fellowship, Fall 2020

Senay Simsek
2020 NC-213 U.S. Quality Grains Research Consortium
2020 Andersons Cereals and Oilseeds Award of Excellence

Pablo Torres Aguilar
Commission on Dietetic Registration Second Century Scholarship, Fall 2020

Adrienne Voelker
Purdue OIGP Bilsland Fellowship, Fall 2020

Yuan Yao
Promoted to rank of full professor
University Faculty Entrepreneurial Scholar Award

E. Special Events

Whistler Center Short Course, October 6, 2020

As is our tradition, the course was designed to provide one day on carbohydrate fundamentals followed by two days of advanced special topic sessions. Due to COVID-19, the Short Course was held online in 2020. We held a full day on October 6, and our advanced courses were held on October 13 and 20. All sessions were recorded so that our members could visit our website to view the recordings. This enabled our members an opportunity to attend all offerings. For individuals subscribing to our Educational Package, the Short Course recordings were available for one month.

- Introduction to carbohydrates: Basic concepts - monosaccharides, oligosaccharides, and polysaccharides, Y. Yao
- Starch granule structure and properties, S. Simsek
- Modifications of starch and other polysaccharides, Y. Yao
- Basic principles in rheology and viscoelasticity, J. Kokini
- Polyols and high-intensity sweeteners, Y. Yao
- Carbohydrate nutrition and labeling, B. Hamaker

October 13, 2020
Hydrocolloids and functionality (Part I & II), J. Keller

Physical property testing (including moisture sorption) of carbohydrates, L. Mauer

Carbohydrates as functional ingredients in cereal-based foods, S. Simsek

Phase stability of polysaccharide mixtures, O. Jones

Dietary phenolic-fiber interactions: Effect on gut health, L. Reddivari

October 20, 2020
Fiber carbohydrate-microbiome interactions, S. Lindemann

Formulating healthy carbohydrate-based foods, M. Martinez

How carbohydrates interact with the gut-brain axis for satiety and weight management, B. Hamaker

Complex carbohydrate structure analysis (non-starch), B. Reuhs

Advances in chemical and physical modifications of starch, S. Simsek and Y. Yao

Extrusions technology for the production of food and non-food materials, O. Campanella

Recognition

Dr. Senay Simsek, a Whistler Center faculty member and Purdue University graduate, is the new head of Purdue's Department of Food Science.

"I have been a proud Purdue graduate during my entire career," Simsek says. "But honestly, I never imagined coming back as the next head. I am thrilled to be given the opportunity to lead a department that I'm very passionate about. I know the history of the department – and that I have big shoes to fill."

After earning her PhD in 2006, she was hired by North Dakota State University. In 2007, she became the director of the Carbohydrate Research and Wheat Quality Program. In 2013, she was the Bert L. D'Appolonia Cereal Science and Technology of Wheat Endowed Associate Professor; five years later the title changed to Endowed Professor. Her research focuses on structure function applications of carbohydrates for improvement of nutritional, immunological and value adding strategies of cereal grains, grain byproducts and other sources of carbohydrates.

Dr. Karen Plaut, the Glenn W. Sample Dean of the College of Agriculture, says Simsek "is recognized nationally and internationally for her contributions in cereal chemistry. She is an innovative, passionate leader who knows how to move things forward."

Simsek's faculty membership with the Whistler Center began in 2019, and she expects it will continue, as her schedule allows. She will work in the Philip E. Nelson Hall of Food Science, named for the former department head, professor emeritus and recipient of the World Food Prize. She recalls "multiple opportunities to see him and hear his inspiring talks" during her years in West Lafayette. "He was one of the first people to congratulate me on my new role. He is very passionate about the department, and his vision is still alive today."

North Dakota State's "very diverse and sizable agricultural program significantly contributed to my professional development," she says. She also "learned how to enjoy winter," referring to ice skating, skiing and sledding.

"I am sad to leave friends in North Dakota, but I am very excited about coming back to Purdue, working with old friends and meeting amazing new people. I also enjoy experiencing four seasons in one day in Indiana."

Her journey

- 2019: Faculty Member, Whistler Center for Carbohydrate Research, Purdue University
- 2018: Bert L. D'Appolonia Cereal Science and Technology of Wheat Endowed Professor, Department of Plant Sciences, North Dakota State University
- 2018: Adjunct Professor, Food Science Program, University of Puerto Rico-Mayaguez
- 2013-2018: Bert L. D'Appolonia Cereal Science and Technology of Wheat Endowed Associate Professor, Department of Plant Sciences, North Dakota State University
- 2007-2013: Assistant Professor, Department of Plant Sciences, North Dakota State University
- 2006, PhD, Food Science, Purdue University. Dissertation: "Host Specificity in *Medicago-SinorhizobiumInteractions:* Structural Characterization of Symbiotically Significant LMW-EPS from *Sinorhizobium meliloti*"
- 2002-2006: Research Assistant, Department of Food Science, Purdue University
- 2000, MS, Biochemistry, Gebze Technical University, Turkey
- 1999-2002: Research Assistant, Department of Biochemistry, Gebze Technical University, Turkey
- 1998, BS, Chemistry, Bulent Ecevit University, Turkey

Bruce Hamaker, Director of the Whistler Center for Carbohydrate Research, received the 2020 Corinne Alexander Spirit of the Land-Grant Mission Award. Established in 2008, the award recognizes faculty members in the Colleges of Agriculture, Veterinary Medicine and Health and Human Sciences working across all three land-grant mission areas: teaching, research and Extension.

2020 Belfort Lecture

2020 Belfort Lecturer

Dr. Bob Rastall

Department of Food and Nutritional Sciences
University of Reading
Earley, England, United Kingdom

The Belfort Lectures were established and endowed by Dr. Anne D. Belfort in memory of her late husband, Dr. Alan M. Belfort, who was awarded a PhD degree from Purdue University in carbohydrate chemistry in 1960. Support for the Belfort Lectures was generously continued by their daughter Anne E. Belfort. Persons honored by being chosen to give a Belfort Lecture are scientists who have made outstanding contributions to glycoscience.

Our 2020 Belfort Lecturer, Professor Bob Rastall, is Senior Tutor, Head of Outreach and Enterprise, and Director of the National Centre for Biotechnology Education within the Department of Food and Nutritional Sciences at the University of Reading in the UK, where he also holds the post of Professor of Food Biotechnology. He has a BSc in Applied Biology and a PhD in Microbial Biochemistry from the University of Greenwich, London. His PhD was on the "Cell-Surface Biochemistry of Erwinia amylovora". He held research fellowships in the field of carbohydrate bioengineering and carbohydrate bioinformatics at the University of Westminster until joining the University of Reading in 1993.

Professor Rastall's research interests are around developing novel enzymatic manufacturing technologies for functional carbohydrates targeted at gut health. His research is mainly focused on the following three areas:

- Understanding structure-function relationships in prebiotic carbohydrates and the application of that knowledge to the rational development of functionally-enhanced prebiotics
- Utilization of waste biomass as a source of novel functional carbohydrates
- Development of rationally targeted probiotics, prebiotics and synbiotics to specific health outcomes and the maintenance of a healthy gut

In Memoriam

Dr. Sakharam K. Patil

It is with great sadness we share with you that our friend Sakharam K. Patil passed away on February 22, 2020, surrounded by his loving family. Dr. Patil served as adjunct faculty for the Whistler Center for Carbohydrate Research from 2005 to 2020.

Dr. Patil was born on April 1, 1941, in Maharashtra, India, to Karson and Kashi Patil. He earned a PhD in Biochemistry from Kansas State University in 1973 and had a successful career as a food scientist. He was vice president of Quality and Technology Transfer at Cerestar USA in Whiting, Indiana. He married Pramila Patil on May 11, 1968. They raised two sons and have four grandchildren. He enjoyed golfing, exercising, and spending time with his family and friends.

Dr. Patil is survived by his wife, Pramila; two sons, Deepak (Anita) and Ravi (Alpa) Patil; and four grandchildren: Naveen, Raina, Aadiv and Ahana.

Sakharam had a generosity of spirit and giving that touched those he knew. He will be missed by the Whistler Center.

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