INDUSTRIAL MEMBERS

(Members of 2015 Industrial Advisory Board)

Archer Daniels Midland

Cargill

Dow AgroSciences

General Mills

Grain Processing Corporation

Kraft Foods

Ingredion

McCain Foods

Mondelēz International

PepsiCo

Roquette

Tate and Lyle

TABLE OF CONTENTS

DIRECTOR'S STATEMENT

Greetings from Purdue and welcome to our 2015 Whistler Center for Carbohydrate Research Annual Report. We all know the world changes quickly nowadays, and that is certainly true in the realm of food carbohydrates. In areas of nutrition and health, carbohydrates in the diet are being viewed differently than before, and not always positively. From our vantage point, we think that carbohydrates, particularly glycemic ones, are viewed too simply and our research shows a complexity of qualities that is health related. Obviously, there are opportunities for better understanding of carbohydrates and their role in health and wellness, and there are a number of other functions of carbohydrates being uncovered at the Center that could improve things like drug and vaccine delivery, assemblages to create new fibrilar and globular macrostructures for creating textures or delivery of bioactives, predictive modeling of carbohydrate functionality, "green" modified starches, to name a few. We and our collaborators within and outside of Purdue work on large interdisciplinary topics involving carbohydrates as delivery systems, dietary fiber structures and targeted function in the gut microbiome, polyphenols and their role in glucose release and delivery to the body, carbohydrate synthesizing enzymes and creation on new structures and their function, and others. We want to be a principal "go-to" research center for investigating food carbohydrates and their functions, and I invite you to peruse through this report to see what we do. If there are items you find of interest, feel free to contact us.

We look to serve our member companies and we feel our interaction with them works best when strong research relationships develop. At our May annual meeting, we provide detailed research reports in the form of morning faculty presentations and an afternoon student/post-doc poster session. In 2015, we had 43 posters. On the second day of the event there is a half-day Technical Conference where the endowed Belfort Lecture is given. This year, Prof. Yong Cheng Shi from Kansas State University presented his fundamental and application-driven research "Modifying starches for nutritional and functional properties". This was complemented with lectures by Prof. Eric Bertoft (Åbo Akademi University, Finland) "Small differences in amylopectin fine structure may explain large functional differences of starch" and Prof. Keith Chadwick (Department of Industrial and Physical Pharmacy, Purdue University) "The role of surfaces in manufacturing drug polymer composite materials", and presentations from Whistler Center faculty. In the fall, we convene our Research Focus Group day-long meeting where, after faculty research updates, we listen to representatives from our member companies on priority areas they would like to see us work on, in the area of pre-competitive fundamental research. We then fund a small number of projects based on the generated topics list, such as strategies to obtain naturally modified starches and water relations with starch to realize improved and consistent starch properties related to texturants and digestion/health property. In October, we had our very successful yearly 3-day Whistler Center Short Course and had approximately 70 participants from our member companies. This free course covers the fundamentals of carbohydrate chemistry, structure and function on day 1, followed by 2 days of advanced topic sessions. This year we had an impressive 15 advanced sessions (see page 76) given by Whistler Center faculty and 4 outside speakers. In November, four Whistler Center faculty traveled to TNO in Zeist, Netherlands for a joint 2-day short course "Carbohydrate and Food Structure; Design for Healthy, Natural Products" conducted with their scientists and outside speakers. This was highly successful and we plan to continue this activity.

We were happy to have Prof. Joe Kokini join the Whistler Center in 2015. Joe holds the Scholle Chair in food process engineering in the Department of Food Science and brings a wealth of experience and research expertise to the Department and Center. He was department Chair at Rutgers University and Associate Dean of Research at University of Illinois Champaign-Urbana. Internationally, in addition to our involvement with TNO mentioned above, we have active formal partnerships between the Whistler Center and Sejong University, South Korea and Jiangnan University, China; and individual faculty visiting professorships at Monterrey Tech (O. Campanella) and Shanghai Jiao Tong University (B. Hamaker).

Find out about the exciting things we do in our 2015 Whistler Center Annual Report.

Sincerely,

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

Starches, Non-Starch Polysaccharides, and Cereals:

A Visiting Scientist working with **Dr. BeMiller** continued studies (until August) on the impacts of the presence of hydrocolloids on the pasting, paste, and gel characteristics of starches by focusing on any effects of the presence of a hydrocolloid on retrogradation (Project 1).

Dr. Campanella's group is developing models to describe food processes that promote the expansion of food products due to high temperatures and bubble growth. These models can be used to simulate the behavior of cereals under processes such as pellet expansion, extrusion, drying, etc. The models incorporate expansion and growth of vapor bubbles and deformable viscoelastic matrices (Project 6). Models to be used to describe non-thermal processes that inactive pathogenic bacteria in beverages are also being developed (Project 7).

O. Campanella and **B. Hamaker** have a second year project to better understand the structural properties of branched starches and their functional properties, and in particular shear thinning and thickening events relevant to processing as well as their digestion (Project 5).

Dr. Mauer's group works on the affect of a variety of sweeteners on starch functional properties (Project 29), and their range of studies on water-solid interactions related to chemical and physical stability of single ingredient and multicomponent food systems (Projects 27, 28).

O. Campanella and **B. Hamaker's** group continued to work on fundamental approaches to functionalize non-wheat cereal storage proteins, with a focus on corn zein. In 2014, Daniel Erickson completed his Ph.D. studies and he published a study that systematically examined changes in the structure and function of zein in the presence of a plasticizer and co-proteins. That project was in collaboration with TNO. The final part of his thesis research was a collaboration with Prof. Sinan Keten from Northwestern University and will be submitted for publication in 2016. Part of that work is continued by Chinmay Joglekar (Project 8) that is focusing in technologies to improve the functionality of proteins such as zein.

Dr. Yao's work in 2015 was closely associated with the carbohydrate biomaterials in food and pharmaceutical areas, with emphases on the pathogen biofilm formation (Project 39), antimicrobial strategy (Project 40), dissolution of active ingredients (Project 41), and high-throughput starch screening (Project 42). In addition, he has re-started the researches on starches of novel resources and novel applications of conventional starches, collaborating with Purdue's College of Veterinary Medicine on the study of carbohydrate nanoparticle-based vaccine adjuvants, and looking at the potential of roll-to-roll technology in preparing active packaging materials for food.

Carbohydrates, Nutrition and Health:

Research continues in the area of carbohydrates and health with expanded work in the area of dietary fiber and the gut microbiota related to health, phytochemicals and glycemic response, carbohydrate triggers to the gut enteroendocrine cells for appetitive response, human studies on carbohydrates and food motility, and viscous polysaccharides and gut bacteria growth. **B. Hamaker's** group is now concentrated mostly on research related to 1) dietary fiber structures, gut microbiota requirements, and functional endpoints (Projects 12, 13); and 2) control of glycemic carbohydrate digestion and cellular (enterocyte) and physiological response (Projects 14, 15) and. The first addresses the question of how dietary fibers (both polysaccharides and oligosaccharides) can be used for targeted microbiota and biological changes in the colon, and the second focuses on ways to moderate glycemic carbohydrate (mostly starch) digestion through examination of molecular fine structures, macro-assemblies and matrices, and at the level of enzyme-substrate relationships, as well as inhibitors.

In studies on dietary fibers and the gut microbiota, **B. Hamaker** and **B. Reuh's** groups have found that very small changes in fiber molecular structures can profoundly affect gut bacteria growth response and that this affects their balance in a completion-based model. Work has been done on individual fibers and fiber mixtures and their effect on short chain fatty acid profiles of individuals with different microbiota compositions, as well as requirements of bacteria and how they compete for fiber substrates (Projects 12, 13). Collaborators are A. Keshavarzian and his group at Rush Medical School, Chicago; E. Martens, U. Michigan Medical School, Ann Arbor; L. Zhao, Shanghai Jiao Tong University, China; and C. Nagler, University of Chicago.

In the glycemic carbohydrate area, an objective has been to understand cellular and physiological responses related to slowly digestible carbohydrates. Cell culture work on both intestinal enterocytes and enteroendocrine L-cells show a sensing of starch degradation products (maltooligosaccharides) with interesting implications (Project 15). Our previously

reported *in vivo* studies have shown change in feeding behavior and lowering of gene expression of hypothalamic appetite-stimulating neuropeptides in animals fed slowly digestible starch. **Hamaker's group** works with a multi-disciplinary collaborative group called "Starch Digestion Consortium" consisting of A. Lin at Purdue, B. Nichols at Baylor College of Medicine, R. Quezada-Calvillo in Mexico, D. Rose and M. Pinto in Canada, and H. Naim in Germany. **Dr. Ferruzzi** developed a Caco-2-model as a predictor of glucose transport, and joint work with **Dr. Hamaker** explores plant phenolics that modify carbohydrate digestion and absorption of glycemic carbohydrates (Project 11).

Dr. Ferruzzi has developed a research program focused on fundamental and applied aspects of both food science and nutrition disciplines. His long-term goal is to identify food science strategies that will contribute to the prevention of chronic disease in humans. Working toward this goal, Dr. Ferruzzi's research program bridges the food and nutrition sciences by investigating the impact of the food matrix and processing on the physical and chemical stability, and bioavailability of phytochemicals. His primary research focus areas include: development of methods for determination of phytochemicals in complex matrices, assessment of phytochemical stability and reactivity in food systems, including interactions with carbohydrate and protein macromolecules, and determination of factors impacting phytochemical bioavailability from foods.

O. Campanella's in collaboration with **B. Hamaker** are investigating the role of viscosity on the growth of gut microbiota as well the production of metabolites using concepts of reactive extrusion to describe the transit of foods through the GI tract (Project 9).

Polysaccharide Structures:

Dr. Janaswamy's research demonstrates the utilization of carbohydrate fibers for the design and development of cost-effective carriers of nutraceuticals, drugs, and antimicrobial compounds. The research idea is about solubilizing functional molecules in an organic solvent and then encapsulating in the water pockets of carbohydrate networks. His study on the encapsulation efficiency and release profiles of carvacrol, an antimicrobial compound, employing sodium iota-carrageenan fibers revealed its sustained release as well as effectively controlling the proliferation of *Salmonella* (Project 16). In another study, iota-carrageenan fibers along with ordered networks of potato, cassava, high amylose maize starches and waxy maize are found to be effective for encapsulating nutraceutical compounds such as curcumin and resveratrol (Project 17). The encapsulation in the starch network favorably alters the starch digestion. The outcome is deemed to be helpful in developing novel and value-added functional foods, food supplements and medicinal foods.

Dr. Jones's research determines the impact of polysaccharides on the development of biopolymer-based structures that have potential application in food systems. Polysaccharides contribute to the development of biopolymer-based structures by forming intermolecular bonds with other components such as proteins, limiting or facilitating assembly processes. Ultimate structures, including particulate, fibrous, or network-like assemblies, can contribute to the stabilization of foam/emulsion interfaces, the formation of highly-functionalized gel or film systems, or the creation of novel vehicles for the controlled release of bioactive molecules. Characterization of structural properties, such as morphology, size, and physical stability, are a key component of **Dr. Jones'** analytical capabilities, and the laboratory possesses state-of-the-art atomic force microscopy and light scattering systems. Since the stoichiometry and energetics of intermolecular interactions with polysaccharides are important considerations, Dr. Jones' laboratory also utilizes calorimetry and spectroscopic techniques that can be applied to a variety of other systems.

Protein-based structures are excellent as model systems for understanding intermolecular assembly and also as industrially-feasible materials if the ultimate value is great enough or the initial protein cost is low enough. For these reasons, **Dr. Jones'** lab has studied fibrous and particulate assemblies of the whey protein β-lactoglobulin, both of which have excellent potential for higher-order functionality in food or health-relevant products. Fibrils formed from β-lactoglobulin have formed and stabilized at neutral pH using techniques developed in our laboratory. We are now using these fibrils to create films to protect/modify foods or to facilitate the growth of cells (Project 18). Particulate assemblies of β-lactoglobulin have also been investigated in our laboratory for the stabilization of emulsions or foams. These particulate structures are a type of deformable microgel, which have been recognized to have unique stabilizing properties for emulsion or foam interfaces. Recent work in our laboratory has demonstrated that the size of such protein particulates can have a crucial impact on their ability to adsorb and stabilize emulsion or foam interfaces, and we are further investigating other physical attributes that may better

control the desired stability of emulsions (Project 19). Particulate assemblies of another protein, zein, are much less physically stable in aqueous solution than the β-lactoglobulin particles yet show excellent promise as controlled release vehicles or textural modifiers. With the aim of improving the utility and understanding of their physical properties during storage and human ingestion, a project has been initiated on the physical stabilization of zein nanoparticles with carbohydrates in aqueous solutions (Project 21).

Assembled structures are not only formed from controlled aggregation of proteins or polysaccharides, but can also result from the attractive interaction between proteins and polysaccharides. However, such structures are often difficult to control, making it challenging to create vehicles for encapsulation and release of molecules with defined physical properties. By attaching an uncharged chain to charged-polysaccharides, we have demonstrated that interactions with protein are restricted and lead to the development of spherical nanometer-scale assemblies (Project 20). Work is currently underway on the formation of such structures from various starting materials and the factors contributing to their ultimate size and dissolution properties.

While hydrocolloids, such as polysaccharide gums, are useful in the preparation of higher-order assemblies or even modifying the texture of commercial products, the maximal utility of these hydrocolloids can only be obtained if they are dispersed and solubilized appropriately. Even though many hydrocolloids are considered highly soluble in water or water-based systems, the large size of hydrocolloids and the physical structure of commercially-available powders demands a varying amount of time and energy to achieve their final solubilized state. Dispersion and solubilization of hydrocolloid powders are truly a physical process, and we are currently identifying the conditions and molecular attributes of a model polysaccharide that contribute to faster or slower dispersion and solubilization in aqueous systems (Project 22).

Rheology:

Dr. Campanella's projects involve rheological and physicochemical characterization of biomaterials including food and non-food materials. The group is interested specifically in properties that are associated with the formation of structures, e.g. during gelling, interaction of polymeric molecules with colloidal particles (e.g. silica), self-assembling of biomolecules, and the structure of fibers and their relevance in the incorporation high content of fibers in foods. The role of these physicochemical properties is also being analyzed in regards to material processability. Changes in proteins structures and their functions by changes in temperature, addition of other macromolecules such as co-proteins are being studied using rheological and spectroscopic techniques (e.g. circular dichroism, FTIR, isothermal calorimetry) and microscopy. Properties of these composite systems such as their rheology, and their structures, and how they affect the material's functional properties are being studied (Projects 3, 8, & 10). Results of this research have an impact on the area of development of new materials and foods with good nutritional and textural qualities.

Development of new materials and understanding the physicochemical behavior of existing ones require a scientific foundation involving modeling and experimental validation. Work in this area also focuses on the functional efficacy of natural polymers used as part of food ingredients (Project 5). Given the complex nature of these materials composition and the various conditions to which they are exposed during processing and storage, stability, functionality and quality under different environmental and processing conditions are key attributes that are being investigated by **O. Campanella's** group. In these projects rheological, thermophysical, spectrocopic and microscopic methods are being developed to study the effects and use of ingredients that can improve the functionality in food and non-food products. For instance model systems are used to understand the mechanisms of viscoelasticity enhancement of non-gluten cereal-based systems like the protein zein. This functional change is believed to be the result of developing fibrous, β-sheet-rich protein networks; however, current understanding of the physicochemical properties of these polymers is limited. This research aims to present mechanistic frameworks for approaching these systems by highlighting structure/function relationships. With **B. Hamaker**, novel physicochemical and rheological methods are being developed to monitor the formation, stability, and scale-up of a nanocomplex formed by the interaction of starch (Project 3).

Interfacial Phenomena:

Dr. Narsimhan's group continues to work on fundamental aspects of interfacial phenomena in food and biological systems. They are investigating pore formation in microbial cell membranes by antimicrobial peptides (Projects 30, 31) and

characterization of connection between structure and pasting behavior of starch (Project 32).

Chemical Structures and Functions of Polysaccharides:

Dr. Reuhs and A. Terekhov run an analytical core facility at the Whistler Center dedicated to complex carbohydrate structural analysis. With **O. Campanella** and **B. Hamaker**, the group studies non-starch polysaccharide structures and their physical functionality (described under Campanella), as well colon fermentation (described under Hamaker). Analysis typically involves monosaccharide profiling using the alditol acetate or TMS-methylk-glycoside analysis by GC, and linkage analysis by partial methylation using GC-MS, as well as 2D-NMR. Other chromatography methods are used to profile molecular size, and as preparative tools. The current research also includes plant-microbe interaction. All of these research efforts are related to understanding the role of polysaccharides in structure-function relations in various biological and food systems

Genetics:

Dr. Weil's lab now has a mutant population (~12,000 lines) of the important staple crop Sorghum bicolor. ~600 of these lines have been fully resequenced to catalogue all the mutations present in each. This database and seed for each mutant line are available to breeders worldwide at www.purdue.edu/sorghumgenomics. Novel mutations are already emerging from these data, including one mutation that lowers the gelatinization temperature of sorghum starch to an extent that could be significant in the brewing of fermented sorghum beverages. Additional mutants in these lines include those that improve the protein digestibility of the cooked sorghum flour, important both for nutritional reasons in the developing world and for the efficient use of dried distiller's grains that are a byproduct of using sorghum as a renewable fuels feedstock. New waxy alleles have also been identified, as well as alleles in starch synthases and debranching enzymes.

We are now expanding these resources to include the "ancient grain" pearl millet. Millet is an increasingly used gluten-free alternative grain coming into wider use in the U.S. that is rich in protein and magnesium and which has particularly valuable traits around naturally slow release of carbohydrates into the bloodstream. Surprisingly, we understand very little about this important crop and have taken very few steps to improve it. However, taking advantage of information we have gained from our studies and the resources available for its close relatives, corn and sorghum, we are pursuing improvement of this grain and its processed flour for broader and novel food uses.

Another project in the lab examines how plants partition the carbon they fix during photosynthesis into different forms and different locations within the plant (Project 36). We are identifying genes that control the ability of the plant to move carbohydrate out of leaves and into the rest of the plant In corn. The most commercial consequence of that movement is typically starch in the kernels of the ear, but in close relatives of corn (sugarcane and sorghum), the carbon can be stored as high levels of sugar in the stalk. Both from a biofuel and from a food ingredient standpoint, it would be useful to develop varieties that grow to large biomass and that accumulate sugar in the stalk, similar to what is observed for sugarcane or sweet sorghums. Several tropical varieties of maize already show significantly higher stalk sugar (as high as 20%) than is typical for corn, and we are pursuing breeding strategies to better understand the genes responsible and their control of this process. In addition, a reverse genetic strategy to knock out specific invertase enzymes to increase stalk sugar is being pursued.

In addition, the regulation of how carbohydrates are partitioned into seed, sugar or biomass is under genetic control, but is poorly understood. Together with colleagues at the University of Missouri, the University of Florida, and St. Michael's College, a NSF-funded project is characterizing the contents, functions and genetic networks that characterize phloem function, carbon partitioning, and yield. The Weil lab has now mapped over 90 of these mutations to candidate intervals on all ten chromosomes in the maize genome, and identification of the genes involved is being pursued. (Project 37).

The Weil lab has continued to characterize mutant lines of corn that show altered starch digestion. One inbred is notable for its more rapidly digested uncooked starch, which has tremendous potential as an improved poultry feed ingredient. Finally, we are investigating the idea that the uses of carbohydrates, specifically phytoglycogen, as a biodegradable, inexpensive and accessible nanomaterial, can be expanded and improved genetically.

STAFF DIRECTORY

Faculty

James N. BeMiller	Professor Emeritus	bemiller@purdue.edu
Osvaldo H. Campanella	Professor	campa@purdue.edu
R. Chandrasekaran	Professor	chandra@purdue.edu
Mario G. Ferruzzi	Professor	mferruzz@purdue.edu
Bruce R. Hamaker	Professor/Director	hamakerb@purdue.edu
Srinivas Janaswamy	Research Assistant Professor	janaswam@purdue.edu
Owen G. Jones	Assistant Professor	joneso@purdue.edu
Jozef Kokini	Professor	jkokini@purdue.edu
Lisa J. Mauer	Professor	mauer@purdue.edu
Ganesan Narsimhan	Professor	narsimha@purdue.edu
Bradley L. Reuhs	Associate Professor	breuhs@purdue.edu
Clifford F. Weil	Professor	cweil@purdue.edu
Yuan Yao	Associate Professor	yao1@purdue.edu

Visiting Professors

Ozlem Duvarci	Kokini	(January – December)
Isabella D'Antuono	Ferruzzi	(February – March)
Jinling Fan	Yao	fan59@purdue.edu
Lingxiao Gong	Yao	gong50@purdue.edu
Wenbin Guo	Campanella	(January – July)
Xiao Hua	Hamaker	(January – September)
Fusheng Zhang	Janaswamy	zhan2005@purdue.edu
Danshi Zhu	Reuhs	zhu565@purdue.edu
Genyi Zhang	Hamaker	(February – August)

Visiting Scientists

Maria Clara Alcala	Kokini	(May – July)
Mustapha Benmoussa	Hamaker	(January – December)
Wladimir Andres Bernys	Yao	(January – April)
Lina Paulina Cabareas	Kokini	(May – July)
Rennan Carreira	Campanella	(December)
Wei-Jen (William) Chang	Lin	(January – May)
Fenglian Chen	Campanella	(January – May)
Lilin Chen	Campanella/Hamaker	cheng288@purdue.edu
Leidy Montoya Devia	Hamaker	(April- October)
Laura Luiza Ferreira	Yao	(May - August)
Yezhi Fu	Yao	fu124@purdue.edu
Zhen Fu	BeMiller	(January – August)
Miguel Alvarez Gonzales	Yao	gonzale1@purdue.edu
Romina Ingrassia	Campanella	(August – November)
Thaisa Jungles	Hamaker	(March – December)
Chunli Lei	Mauer	lei41@purdue.edu
Xiaohui Li	Yao	(January – March)
Alejandra Mencia	Yao	amguevar@purdue.edu
Samantha Abigail Proano	Kokini	(January – April)
Laura M Arango Salazar	Yao	larangos@purdue.edu
Fabiola Ayala Soto	Campanella	(September – December)
Cintya Syozi	Campanella	(October – December)
Han Tao	Hamaker/Campanella	tao58@purdue.edu

Vinícius Valicente	Hamaker/Campanella	(February – December)
Gamze Yazar	Kokini	(January – December)
Fusheng Zhang	Janaswamy	zhan2005@purdue.edu

Ph.D. Students

Matthew Allan	Mauer	mallan@purdue.edu
Jennifer Allen	Ferruzzi	allen211@purdue.edu
Ingrid Aragon Gallego	Ferruzzi	iaragong@purdue.edu
José Bonilla	Kokini	jbonilla@purdue.edu
Tingting Chen	Hamaker	chen921@purdue.edu
Christopher Cheng	Jones	cjcheng@purdue.edu
Dennis Cladis	Ferruzzi/Weaver	dcladis@purdue.edu
Gnana Prasuna Desam	Narsimhan	gdesam@purdue.edu
Aminata Diatta	Hamaker	daminata@purdue.edu
Juan Du	Jones	du2@purdue.edu
Marwa El Hindaway	Hamaker	melhinda@purdue.edu
Necla Mine Eren	Campanella	(January – July)
Fang Fang	Campanella/Hamaker	ffang@purdue.edu
Xing Fei	Campanella/Reuhs	fei2@purdue.edu
Maya Fitriyanti	Narsimhan	mfitriya@purdue.edu
Menglu Gao	Kokini	gao143@purdue.edu
Jay Gilbert	Jones	gilber26@purdue.edu
Anna Hayes	Hamaker	hayes100@purdue.edu
Chinmay Joglekar	Campanella/Hamaker	cjoglekar@purdue.edu
Kin Lau	Weil	lau3@purdue.edu
Jinsha Li	Narsimhan	li1508@purdue.edu
Jongbin Lim	Hamaker	lim175@purdue.edu
Yuan Lv	Narsimhan	lv10@purdue.edu
Luis Maldonado	Kokini	lmaldona@purdue.edu
Krystin Marrs	Mauer	(January – August)
Joel Meehl	Ferruzzi/Hamaker	jmeehl@purdue.edu
Sydney Moser	Ferruzzi	moser6@purdue.edu
Ryan Murphy	Jones	murph170@purdue.edu
Cheikh Ndiaye	Ferruzzi	cndiaye@purdue.edu
Xin Nie	Hamaker/Reuhs	nie3@purdue.edu
Xiang Ning	Narsimhan	xiangn@purdue.edu
Smith Nkhata	Ferruzzi/Hamaker	snkhata@purdue.edu
Gabriella M.C. de Oliveira	Campanella	gmendesc@purdue.edu
Darwin Ortiz	Ferruzzi	dortizos@purdue.edu
Xingyun Peng	Yao	peng97@purdue.edu
Beth Pletsch	Hamaker	epletsch@purdue.edu
Benjamin Redan	Ferruzzi	bredan@purdue.edu
Rándol J. Rodríguez	Yao	rodrigrj@purdue.edu
Tahrima Binte Rouf	Kokini	trouf@purdue.edu
Leigh Schmidt	Hamaker	lcrschmidt@purdue.edu
Pablo Torres-Aguilar	Hamaker	ptorresa@purdue.edu
Seda Arioglu-Tuncil	Mauer	sarioglu@purdue.edu
Yunus Tuncil	Hamaker	ytuncil@purdue.edu
Xi Wu	Narsimhan	wu403@purdue.edu
Ying Xie	Yao	xie96@purdue.edu
Ximena Yepez	Kokini	xyepez@purdue.edu
Xiaowei Zhang	Hamaker	zhan1982@purdue.edu

M.S. Students

Emma Barber	Kokini	barber2@purdue.edu
Carlos Carter	Janaswamy	carte135@purdue.edu
Amber Furrer	Ferruzzi	(January – August)
Kathryn Johnson	Mauer	john1772@purdue.edu
Enosh Kazem	Hamaker	akazem@purdue.edu
Dongdong Ma	Campanella	dongdongma812@purdue.edu
Moriah Massafaro	Weil	(January – December)
Lohit Myneedu	Janaswamy	(January – May)
Cheikh Ndiaye	Ferruzzi	cndiaye@purdue.edu
Juan Sanchez	Mauer	sanch102@purdue.edu
Ana Steen	Campanella/Hamaker	(January – September)
Hazal Turasan	Kokini	hturasan@purdue.edu
Tianming Yao	Janaswamy	yao132@purdue.edu

Ph.D. Post-doctoral Research Associates

Mohammad Chegeni	Hamaker	mchegeni@purdue.edu
Dave Huizinga	Weil	dhuizing@purdue.edu
Rosy Hatch	Weil	hatchr@purdue.edu
Cheng Li	Hamaker	li2321@purdue.edu
Min Li	Ferruzzi	li918@purdue.edu
Bhavesh Patel	Campanella/Hamaker	bkpatel30@gmail.com
Rohollah Sadeghi	Kokini	rsadeghi@purdue.edu
Julia Spotti	Jones	mspotti@purdue.edu
Alpana Thorat	Mauer	thorat@purdue.edu
Bin Zhang	Hamaker	binzhang@purdue.edu

Staff

Mikaela Allan	Administrative Coordinator	measter@purdue.edu
Anton Terekhov	Director of Analytical Services	aterekho@purdue.edu

James N. BeMiller

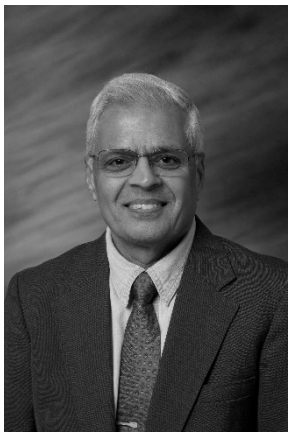
GENERAL RESEARCH AREAS
- Starch
- Carbohydrate chemistry

SPECIFIC RESEARCH AREAS
- Starch granule structure, reactivity, and behaviors
- Chemical and biological modifications of starch
- Structure-functional property relationships of polysaccharides
- Starch-hydrocolloid interactions
- Uses of carbohydrates in food and other commercial applications

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
- On-line 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
- Extrusion; role of rheology in the extrusion process



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
- Implementation of modern techniques to fiber diffraction

Mario G. Ferruzzi

GENERAL RESEARCH AREAS

- Phytochemical and botanical chemistry with focus on food pigments and flavonoids
- Development of methodologies for determination of phytochemicals in food and biological matrices
- Investigation of food processing effects on phytochemical profiles, bioavailability, and ultimate bioactivity
- Development of strategies for incorporation and stabilization of phytochemicals in food systems

Bruce R. Hamaker

GENERAL RESEARCH AREAS

- Glycemic carbohydrates and health
- Dietary fibers and gut microbiota
- Starch chemistry and functionality
- Cereal chemistry and functionality

SPECIFIC RESEARCH AREAS

- Starch digestion control, low glycemic response/slow digestion and physiologic response
- Dietary fiber, modifications in functionality and colon fermentability, microbiota changes
- Cereal starch and protein functionality
- Functional properties influenced by starch fine structure
- Interactions between starch and other food components
- Appropriate methods of improving cereal utilization in developing countries

Srinivas Janaswamy

GENERAL RESEARCH AREAS

- X-ray crystallography
- Biopolymers structure and functionality

SPECIFIC RESEARCH AREAS

- Molecular structure, junction zone details of polysaccharides and polysaccharide blends and relationships to macroscopic behavior
- Developing novel and cost effective delivery systems using food hydrocolloids
- Structure-function relationships in biomaterials
- Tailoring polysaccharide structures for improved functionality
- Molecular dynamics simulations
- Starch crystallinity
- Biotexture of plant tissue derivatives

Owen G. Jones

GENERAL RESEARCH AREAS

- Investigation of physical interactions between food biopolymers, such as milk proteins and fibrous polysaccharides
- Investigations of assembled structures through physical interactions and environmental changes, such as pH, temperature, and dielectric constant
- Development of assembled structures for the design of controlled release systems or materials with novel behaviors
- Determination of micro-scale structural/mechanical properties in complex biological materials

SPECIFIC RESEARCH AREAS

- Controlling the physical properties of assembled protein microgels
- Adsorption of protein microgels to aqueous interfaces
- Micelle-like complexes formed form protein and modified polysaccharide
- Interactions between bioactive small molecules and proteins
- Physical stabilization of insoluble zein nanoparticles
- Structural-mechanical behavior of protein fibril films for food and pharmaceutical application
- Physicochemical factors in the dispersion rate of a food-grade hydrocolloid

Jozef Kokini

GENERAL RESEARCH AREAS

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

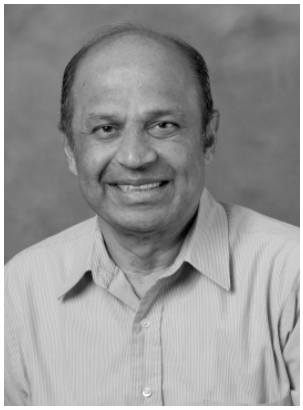
Lisa J. Mauer

GENERAL RESEARCH AREAS

- Food chemistry
- Water-solid interactions

SPECIFIC RESEARCH AREAS

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



Ganesan Narsimhan

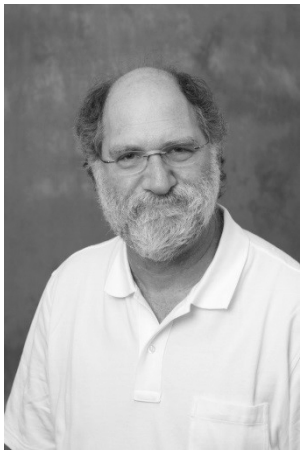
GENERAL RESEARCH AREAS
- Emulsions and foams
- Biopolymer interactions

SPECIFIC RESEARCH AREAS
- Pore formation by antimicrobial peptides in cell membranes and lipid bilayers
- Pasting behavior and 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

Bradley L. Reuhs

GENERAL RESEARCH AREAS
- Polysaccharide analysis / hydrocolloid analysis
- Plant cell wall compositions, structures, and functions
- Bacterial cell wall compositions, structures, and functions

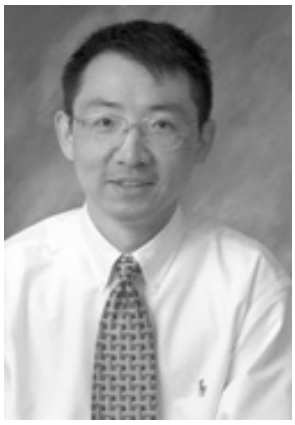
SPECIFIC RESEARCH AREAS
- Extractions and purification of acidic polysaccharides from cell walls of plants
- and bacteria
- Fiber analysis
- Pectin analysis
- Capsule, gum, and lipopolysaccharides analysis
- Application of HPLC, GC-MS, and NMR to structural studies of carbohydrates, including polysaccharides
- Role of polysaccharides in bacteria-legume symbiosis
- Detection of bacteria in plant roots



Clifford F. Weil

GENERAL RESEARCH AREAS
- Plant classical and molecular genetics
- Genomics of starch digestion, composition and architecture
- Genetics of carbohydrate redistribution in plants
- Gene expression
- Large-scale forward and reverse genetics screening
- Genome maintenance and organization

SPECIFIC RESEARCH AREAS
- Rational redesign of corn, sorghum and millet starch composition
- Sugar accumulation in grass crops
- Genetic control of starch and protein digestibility in corn and sorghum
- Genetic modification of corn starch properties



Yuan Yao

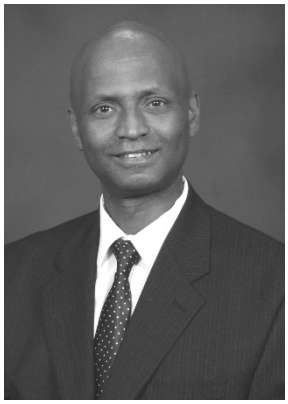
GENERAL RESEARCH AREAS

- Biomaterials and carbohydrate chemistry
- Nanotechnology
- Stabilization of active ingredients

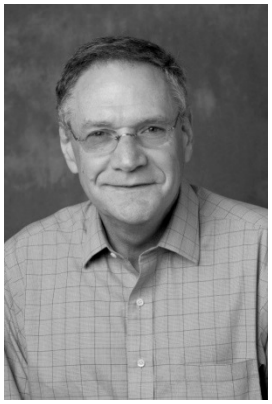
SPECIFIC RESEARCH AREAS

- Dendrimer-like biopolymers
- Nanotechnology for enhanced food quality and safety
- Genetic, enzymatic, and chemical modifications of carbohydrates
- Functional emulsion systems
- Formulations for food nutraceuticals

ADJUNCT FACULTY



Yonas Gizaw, Ph.D. is Principal Scientist at The Procter and Gamble Co. Currently; he is technical leader for Advanced Cleaning Transformative Platform Technologies in Corporate R&D. Dr. Gizaw is 19 years 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 Fabric Care Strategic and Innovation division where he where was responsible development of strategic technologies Downy/Lenor & Tide/Ariel etc. Since 2012, He joined Corporate Research – Transformative Platform Technologies. Prior to joining P&G Dr. Gizaw received his doctoral degree from Purdue University in synthetic carbohydrate chemistry.

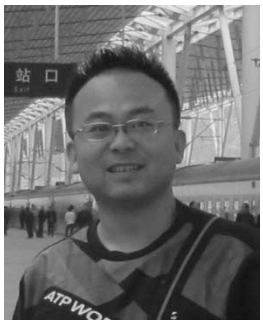


Akiva Gross, Ph.D. is President of A.T. Gross Consulting, Ltd. Dr. Gross received his doctoral degree in Organic Chemistry from the Weizmann Institute of Science in Israel and then continued his scientific training in Applied Enzymology in the chemistry departments of Massachusetts Institute of Technology 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.

Sakharam K. Patil, Ph.D. is President of S.K. Patil and Associates. Dr. Patil was awarded a Ph.D. degree in Cereal Science by Kansas State University in 1973. He held several positions at American Maize Products Co., later Cerestar, from 1978 until his retirement in 2002. The positions included VP Marketing and Commercial Development (1994-1995), VP R&D (1995-2000), VP R&D and Director, Global, Technology Transfer (2000-2001), and VP Quality and Technology Transfer (2002). His expertise includes cereal chemistry, ingredient technology (food and industrial), technology transfer, marketing/commercial development, training/coaching, cross-functional team development, global business development and strategic management.

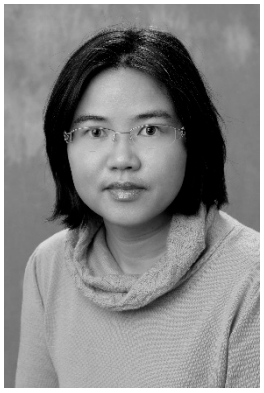
VISITING PROFESSORS

Jinling Fan, a professor at Henan University of Science and Technology, completed her M.S. degree in Processing and Storage of Agriculture Products from Shenyang Agricultural University in 1997 in China. After that, she completed her Ph.D. in Food Science at Jiangnan University. She joined Dr. Yao's group in September 2015 as a visiting professor. Her research focuses on development of strategies for incorporation and stabilization of phytochemicals in food systems.

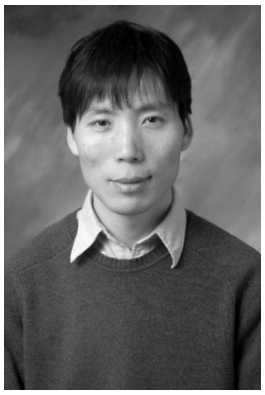


Wenbin Guo earned a Ph.D. from Inner Mongolia Agricultural University in 2009. He arrived to Purdue in August 2014 and is Lecturer at the College of Mechanical and Electrical Engineering Inner Mongolia Agricultural University Hohhot, Inner Mongolia Autonomous Region, 010018 P. R. of China. Wenbin working on novel rheological methods to characterize the viscoelastic properties of vegetables and agricultural products and how they relate to the physical composition notably the water content of these materials. He returned to his country on July 2015.

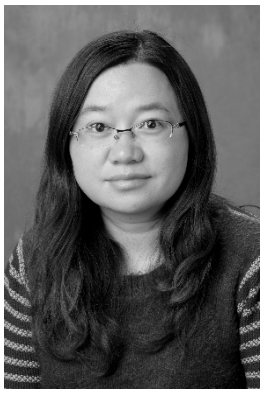
Xiao Hua received his Ph.D. in Material Science from Nanjing University of Science and Technology, and now is a faculty member in the School of Food Science and Technology, Jiangnan University. His research mainly focuses on food hydrocolloids and oligosaccharides. He worked in Dr. Hamaker's group from August 2014 to September 2015, researching the development of cellulose hydrolyzates and their utilization by microorganisms from the human gut.



Xiaohui Li is an Associate Professor in the College of Food Science & Technology, Shanghai Ocean University, with her research focusing lysozyme antibacterial characterization. In Dr. Yao's group, she works on literature studies related to the delivery of antimicrobial compounds and encapsulation technology.



Genyi Zhang earned a B.S. degree in biology from Lanzhou University and a M.S. degree in genetics from the Institute of Genetics, Academia Sinica, Beijing. He obtained a second M.S. degree at Purdue investigating sorghum starch digestibility and a Ph.D. researching a three-component nanocomplex. He joined the Whistler Center as a Visiting Professor from Southern Yangtze University in December 2004, where he researched alternative ways to achieve, and fundamental structures of, slowly digestible starches. Dr. Zhang is a Professor of Food Science at Jiangnan University, mainly focusing on the carbohydrate chemistry and nutritional properties of starch, and related to this, nutritional interference to prevent or delay the incidence of chronic diseases (diabetes) using functional food components. He also works on soft matter nanotechnology for functional component encapsulation and delivery.



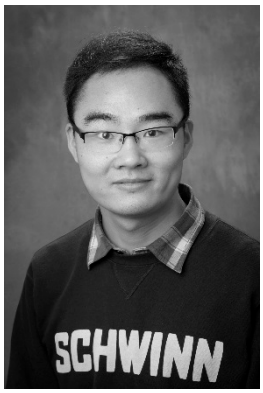
Danshi Zhu completed her B.S. and M.S. in food science of Jiangnan University of China in 2005, and her Ph.D. degree from Shenyang Agriculture University of China in 2014. Danshi Zhu has worked in Bhai University as a faculty since 2007, and now she is an associate professor. She joined Dr. Reuhs's group on September 2015 as a visiting scholar. Her research explored the mechanism of retention viscosity of tomato products by polysaccharides and monosaccharides.

VISITING SCIENTISTS

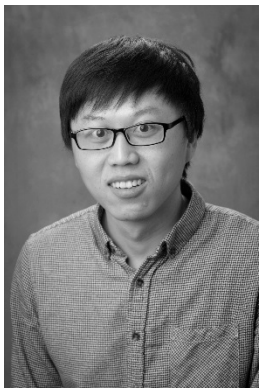
Mustapha Benmoussa received his Ph.D. degree from Laval University (Canada) in Plant Molecular Biology. His Ph.D. research project focused on potato flour viscoelastic proprieties improvement by expression of wheat glutenin in tubers. Mustapha spent two years working on corn storage proteins in the Pediatric Metabolism and Genetics Department, Indiana University as a post-doctoral research associate. Most recently, in his work at the Whistler Center for Carbohydrate Research, he has worked on non-food applications of modified starches such as for wastewater treatment and microalgae flocculation.

Fenglian Chen earned her Ph.D. in 2006 in Engineering focusing on intensive processing of wheat bran by using biotechnological techniques from Material Science and Engineering College, Northeast Forestry University, Harbin, China. She is an Associate Professor in the Department of Food Science and Technology, College of Food Engineering, Harbin University of Commerce (HUC). She arrived at Purdue in November 2014 and stayed until May 2015 working on the rheological evaluation of different kind of rice powders having different amylose/amylopectin ratios, starch and protein content, texture characteristics and microstructure.

Lilin Cheng earned his B.S. in Food Safety and Quality from Shihezi University in 2011 and then he went to Jiangnan University to pursue his M.S. and PhD degree in Food Science and Engineering. He by-passed his MS in 2012. He is now a visiting student at Purdue from 2015 and co-advised by Dr. Campanella and Dr. Hamaker. His research focuses on a three component interaction and simulation of the nanocomplex.



Yezhi Fu earned his B.S. in Food Quality & Safety in 2011 and received his M.S. in Food Engineering in 2014 from China Agricultural University. Now he is in Dr. Yao's research team and researches antimicrobial formulations with or without delivery systems for fresh and fresh-cut produce.

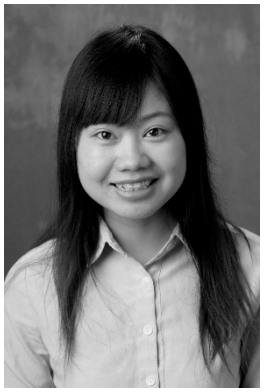


Zhen Fu was a visiting scientist in Dr. BeMiller's lab from September 2014 until August 2105. His research focused on effects of hydrocolloids on starch retrogradation and the effects of high-speed jet treatment on the properties of rice starch. The research he did was part of his Ph.D. thesis in Food Science and Technology in the College of Food Science, Nanchang University, Nanchang, China.

Lingxiao Gong obtained her Ph.D. Degree from the Department of Food Science and Nutrition of Zhejiang University in China. She worked in Dr. Yao's group to establish a high-throughput, single-kernel screening procedure for novel cereal starch and enhanced nutrients.

Miguel Alvarez Gonzales obtained his B.S. degree in Food Science and Technology from Zamorano University, Honduras. His research was on development of a cashew nut-based butter (*Anacardium occidentale* L) with antioxidants BHA and TBHQ. He joined Dr. Yao's group in 2015 as a visiting scholar; where he is working on design of carbohydrates.

Thaisa Jungles earned her B.S. in Human Nutrition from the Pontifical Catholic University – PR in Brazil in 2008. She obtained her M.S. degree from the Department of Biochemistry and Molecular Biology of Paraná Federal University in February 2013, and started her Ph.D. studies in the same year. She joined Dr. Hamaker's group as a visiting student in March 2015, with the support from the Ministry of Science, Technology and Innovation of Brazil. Her research is on the relationship between dietary fibers structural features and its effects on colon microbiota.



Chunli Lei received her B.S. in Chemistry from China Agricultural University (2014) in China. After that, she continued her M.S. studies at the same university. She joined Dr. Mauer's group on September 2015 as a visiting scholar with the support of China Scholarship Council. Her current project focuses on the study of physicochemical stability of thiamine mononitrate solid dispersions.

Alejandra Mencía graduated from Zamorano University, Honduras with a B.S. in Food Science and Technology where her research was on inulin as a fat replacer in low sodium chicken frankfurters. She received her M.S. degree in Food Science from National Pingtung University of Science and Technology, Taiwan on iron fortification of a fermented whey beverage for School Lunch Programs. Currently she is working as a visiting scholar in Dr. Yao's lab working on fluorescent labeling of carbohydrate nanoparticles.

Laura M Arango Salazar obtained her B.S. degree in Chemistry from the Universidad del Valle, Cali, Colombia. Her senior thesis was titled "The nutritional benefits of the peach palm fruit". She joined the Whistler Center in February 2014, and works on the quantitative chemical analysis of starch and monosaccharide residues.

Han Tao is currently a Ph.D. candidate in Food Science at Jiangnan University. Her Ph.D. research was on wheat starch and its non-starch constituents, how they impact frozen bread quality and functionality. She joined Drs. Hamaker and Campanella's group as a visiting scholar from August 2015. Her research is on the effect of viscosity on the growth of gut microbiota.

Vinícius M. Valicente is an undergraduate student at Federal University of Vicosa, in Brazil. In his previous internships he has worked with antioxidants and bioactive compounds, milk and dairy products, and as a consultant to improve the physicochemical stability of a sauce with high fat content. Vinícius joined Drs. Hamaker and Campanella`s group in March 2015 and has worked on methods to process functional dietary fibers.

Gamze Yazar received her M.S. in Cereal Science and Technology in 2010 at the Food Engineering department of Ege University, Turkey. She joined Dr. Kokini's lab in 2013 to be able to carry out the experimental part of her Ph.D. studies. Her studies are focused on the non-linear rheological behavior of wheat flour samples and the gluten fractions to be able to bring an in-depth understanding to the functionality of gluten fractions in dough formation and to create a basis for understanding the rheology of gluten-free dough formulations.

Fusheng Zhang is an Associate Professor in the College of Food Science at Southwest University, China. He received his Ph.D. degree from China Agricultural University in 2011. Dr. Zhang joined Dr. Srinivas Janaswamy's lab as a visiting scientist in July 2014. His research is on structure-function relationships of konjac glucomannan and its mixtures prepared through non-thermal processing and normal treatment.

GRADUATE STUDENTS

Matthew Allan graduated from Washington State University in May 2012 with a B.S. in Food Science. He joined Dr. Lisa Mauer's lab in 2012 and received his M.S. degree in Food Science in August 2014. He is currently working toward earning his Ph.D. with Dr. Mauer. His main research focus is water-solid interactions involving crystalline and amorphous solids.

Jennifer Allen received her B.S in Food Science & Human Nutrition from the University of Illinois at Urbana-Champaign in 2004. She began her career at Michael Foods Inc. where she spent 5 years working in research and development. In 2012, she obtained a M.S in Food Science & Technology from Alabama A&M University where her research focused on the preventative effects of diets consisting of soy, flaxseed, and probiotics on colorectal cancer. Jennifer joined Dr. Ferruzzi's lab in 2012, where her research now focuses on the interactions of proteins with polyphenols and their subsequent effect on the protein's functionality as well as polyphenol bioavailability and bioaccessibility.

Ingrid J. Aragón Gallego earned her B.S in Chemistry from Universidad del Valle, Cali, Colombia in 2009. Her undergraduate thesis was on the validation of *in vitro* methodology for evaluation of iron bioaccessibility in foods. Afterwards, she joined the Nutritional Quality Laboratory (NQL) of the International Center for Tropical Agriculture (CIAT) (Palmira, Colombia) as Research Assistant in 2009. Her works focused in the development, implementation, and validation of analytical methodologies applied for evaluation of bioactive compounds and their antioxidant activity and *in vitro* bioaccessibility. Also, she participated in the development of different research projects in the cassava and bean breeding programs at CIAT, focused in carotenoids and Fe/Zn biofortification of cassava and beans, respectively. In 2014, she joined Dr. Ferruzzi's lab as a Ph.D. student via a scholarship received through the Colombian government. Her research focuses on the nutritional and bioactive value of biofortified staple crops and native foods of Colombia.

Emma Barber received her B.S. in Chemical and Biomolecular Engineering with a minor in Food Science from North Carolina State University in 2014. She joined Purdue in 2014 as well, working on her Master's Degree in Food Science with Dr. Jozef Kokini. Emma's research focuses on optimizing a biodegradable corn protein platform for the spectroscopic detection of allergens and toxins.

José Bonilla earned his B.S. Degree in December 2014 from the Food Science Department at Zamorano University in Honduras. During the spring of 2014, he worked as visiting scholar in Dr. Yao's lab using polysaccharides from starch to improve thymol solubility. In January 2015, he started his direct doctoral from bachelor's degree in Dr. Konini's lab. His Ph.D. research focuses 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.

Carlos Carter received his B.S. degree in Food and Nutritional Sciences at North Carolina Agricultural and Technical State University in Greensboro, NC. His undergraduate research focused on factors influencing greek yogurt in acid whey production. He joined Dr. Srinivas Janaswamy's Lab in fall 2014 as an Industry Fellow in the Department of Food Science. His Master's research is on developing polysaccharide-based essential oil carriers as antimicrobial inhibitors.

Tingting Chen received her B.S. and M.S. degree in Food Science and Technology from Nanchang University. Her M.S. study was about immunoassay development for small-molecular food contaminants. She joined the Dr. Hamaker's group and started her Ph.D. in August 2011 with a governmental scholarship from China Scholarship Council. Her Ph.D. research focuses on dietary fiber structure, gut microbiota, and colon health.

Chris Cheng completed his B.S. in Food Science at Purdue University in 2012. He then received his M.S. at North Carolina State University in 2014. He is currently pursuing his Ph.D. under Dr. Jones doing research on zein protein.

Dennis Cladis earned his B.A. in Chemistry and Mathematics from DePauw University in 2009. He completed his M.S. in synthetic inorganic chemistry at Purdue in 2012. From there, he discovered a passion for food science as a practical application of his chemistry and subsequently earned his M.S. in food science at Purdue in 2014, with his research focusing on fatty acid profiles and mercury content in fish. Currently, he is pursuing his Ph.D. under the direction of Dr. Ferruzzi and Dr. Weaver. His research examines the absorption, distribution, metabolism and elimination of natural plant polyphenols as well as screening toxicity of natural products.

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. Narsimhan's group in June 2015 to pursue a Ph.D. degree in the Department of Agricultural and Biological Engineering and is working on Prediction of swelling kinetics of waxy corn starch and modified waxy corn starch.

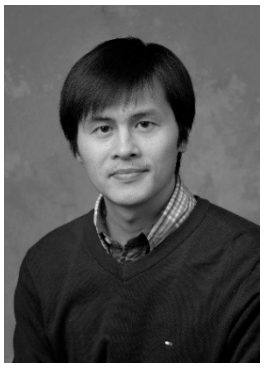
Aminata Diatta received a B.S. in Natural Sciences in 2002 and a pre-doctorate diploma in Chemistry and Biochemistry of Natural Products in 2006 from Cheikh Anta Diop University, Dakar, Senegal. She worked on the theme: "Characterization of three varieties of sorghum (S. bicolor), composition and aptitude to form rolled flour products". She joined Dr. Hamaker's group in the fall 2015.

Juan Du received a B.S. in Food Science from Purdue University in 2009. She finished her M.S. in Food Science from University of Wisconsin-Madison in Dairy Chemistry. She came back to Purdue University in 2013 to pursue her Ph.D. degree in Food Science with Dr. Owen Jones. Her research focuses on interactions between polysaccharides and proteins.

Marwa El Hindaway is from Cairo, Egypt and is pursuing her Ph.D. degree with Dr. Hamaker. She earned her Bachelor and Master's degrees in biochemistry from Egypt and now her research focuses on dietary carbohydrate sensing by small intestine enterocytes, glucose release, and feedback responses.

Necla Mine Eren received a B.S. degree in Food Engineering from Ankara University, Turkey in 2009. Necla came to Purdue in August 2010 as a M.S. student and completed her degree in May 2012. Her Ph.D. focused on physical-chemistry of colloidal nano-particle interactions, specifically exploring on the micro-microstructure relationship. In her research she has gained experience on rheological methods, laser scattering techniques (static and dynamic) and other molecular techniques such as circular dichroism and isothermal titration calorimetry, the latter to characterize the binding of macromolecules into solid surfaces. Besides her research, she took leadership roles in different student organizations and served as the symposium chair of the First Annual Graduate Student Research Symposium in the ABE department. Mine completed her Ph.D. work in July and she was a post-doc at Purdue in the Aviation Technology Department working with aviation fuels before taking a research engineer position with Abbott Nutrition, Columbus, Ohio.

Fang Fang earned her B.S. in Bioengineering from Central South University of Forestry and Technology in 2009 and her M.S. in Food Science from Jiangnan University in 2012. Fang began her Ph.D. at Purdue in the fall of 2013 with support from the China Scholarship Council. She is co-advised by Drs. Campanella and Hamaker. Her research focuses on the relationship between rheology and digestion properties of starch with respect to molecular structure. During 2015 she completed her preliminary examination and now is working to complete her PhD dissertation in spring 2017.



Xing Fei earned his B.S. in 2006 from Huazhong Agricultural University and his M.S. in Food Science from Guangdong Ocean University, China in 2009. Xing began his Ph.D. at Purdue in spring 2014 in Agriculture and Biological Engineering. His research is on the mechanical properties of single molecules and specifically on the characterization of particles composing tomato products processed under different conditions. Xing Fei is also working under the supervision of Bradley Reuhs on the structural characterization of pectins isolated from processed tomato. Professor Owen Jones is also assisting Xing in aspects related to the characterization of particles using AMF. Xing passed his qualifying exam in the Agricultural and Biological Engineering Department and is expecting to complete his PhD in spring 2017.

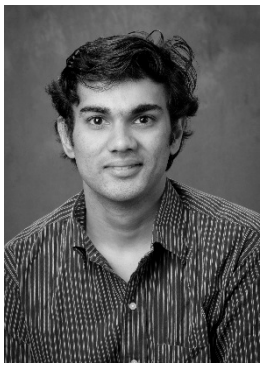
Maya Fitriyanti completed her B.S. in Microbiology from Bandung Institute of Technology, Indonesia, in 2008 and M.S degree in Chemical Engineering from Bandung Institute of Technology, Indonesia, in 2012. She began her Ph.D. at Agricultural and Biological Engineering Department at Purdue University in the fall of 2015 and joined Dr. Ganesan Narsimhan's research group. Her research will focus on development of a process for production of antimicrobial peptides (AMPs) from soybean.

Amber Furrer received her Honors B.S. in Food Science with a minor in Foods and Nutrition from Purdue University in 2013. She received a M.S. degree in Food Science in August of 2015 with a concentration in Foods for Health under Dr. Mario Ferruzzi. Her research focused on content and process stability of phytochemicals in potatoes.

Menglu Gao received her B.S. in Food Science from Purdue University in May 2015. She joined Dr. Kokini's lab in June 2015 to pursue her Ph.D. degree. Her research will focus on numerical simulation and modeling of rheological behavior of dough during processing.

Jay Gilbert began attending Purdue University in August 2013. He received his B.S. degree in Food Science and Technology from the University of Massachusetts Amherst in May 2013. He by-passed his M.S. degree and is working towards his Ph.D. He is advised by Dr. Owen Jones and his research focuses on the stability of protein fibrils for use in food, packaging, and pharmaceutical applications.

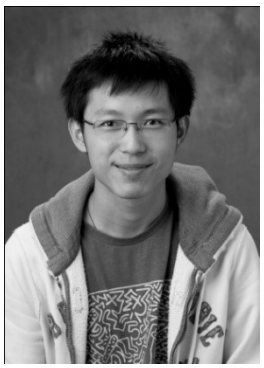
Anna Hayes received her B.S. in Food and Nutrition Science and her B.A. in Spanish from Saint Catherine University (Saint Paul, MN) in May 2014. Anna arrived at Purdue University in August 2014 and intends to by-pass her M.S. and go directly for her Ph.D. Her research focuses on elucidating the locational delivery of carbohydrates in the small intestine and on determining the effects of particle size and viscosity on carbohydrate metabolism.



Chinmay Joglekar received his B.S. in Chemical Engineering from Institute of Chemical Technology, Mumbai, India in June 2011. After completing his M.S. in Chemical Engineering from Purdue University, he joined the Agricultural and Biological Engineering Department in August 2014 to pursue his Ph.D. degree. He is co-advised by Drs. Campanella, Hamaker, and BeMiller. His research focuses on functionalization of corn zein protein.

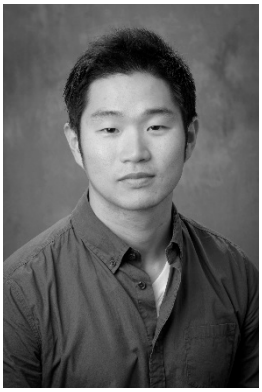
Kathryn Johnson received her B.S.A. in Food Science and B.S. in Chemistry from the University of Georgia in December 2013. She worked at Golden State Foods in Conyers, GA as a Product Development Food Technologist before joining Dr. Mauer's lab as an Industry Fellow in fall 2015 to pursue a M.S. in Food Science. Her current research investigates the effects of different sweeteners on starch thermal properties and behaviors.

Enosh Kazem received his B.S. in Food Science from Purdue University in 2011. After graduation, he spent two years in medical school at Indiana University, but decided to come back into Food Science to work in Dr. Hamaker's group where his research focuses on the role of fiber in colon health.



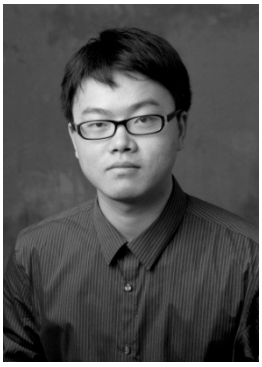
Kin Lau earned his B.S. degree in Biology from Davidson College in May 2010 where he conducted research in synthetic biology using *E. coli* as a model organism. He is currently pursuing a Ph.D. in Plant Breeding and Genetics in the lab of Dr. Weil. His main project is to identify modifiers of certain developmental mutations and to map and clone those modifier genes.

Jinsha Li completed her B.S. in Biosystem Engineering at Michigan State University in 2013. She joined Dr. Engelberth's group in Aug. 2013. In July 2015, she successfully defended her M.S thesis in Agricultural and Biological Engineering, titled "Adding value to bio-ethanol production: quantification and recovery of lutein and zeaxanthin from DDGS". In the same year, she started Ph.D. study with Dr. Narsimhan and has been working on project "Prediction of swelling kinetics of waxy native maize starch" since then. Jinsha is the recipient of Fredrick N. Andrews Fellowship.



Jongbin Lim earned his M.S. degree in Food Science and Technology from Sejong University in South Korea. He joined Dr. Hamaker's lab group in August 2014 to begin his doctoral work. His research is 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.

Yuan Lyu (Yuan Lv) earned her B.S. degree in College of Life Science from Henan Normal University in July 2010, and M.S. degree in School of Life Science from East China Normal University in Jul 2013. Her M.S. research was on development of soybean products, including isolated soybean protein and dietary soybean fiber. Yuan joined Dr. Ganesan Narsimhan's lab in Aug 2013 in pursuit of a Ph.D. degree. Her current research focuses on strategies to obtain antimicrobial peptide from soybean protein.



Dongdong Ma received a B.S. degree in Food Science from Purdue University in 2013. He is currently completing his M.S Degree in Agricultural and Biological Engineering. Dongdong is characterizing the rheology of complex materials and in particular its effects on the processing of these materials, including baking, and drying. He is also specializing on numerical methods to characterize phenomena of heat and mass transfer through viscoelastic materials such as biofilms. Dongdong is planning to complete his M.S. degree in the summer of 2016.

Luis Maldonado received his B.S. degree in Food Science and Technology from Zamorano University, Honduras. His undergraduate research focused on the evaluation of the pasteurization temperature and final acidity on the stability of calcium and vitamin D in yogurt. Before coming to Purdue, he worked for 3 years as a technical advisor for food processing companies in Honduras. He joined Dr. Kokini's lab in fall 2013**.** His Ph.D. research focuses on the characterization and encapsulation of bioactive compounds with nanomaterials.

Krystin Marrs received a B.S.A. in Food Science and a B.S.A.B. in Applied Biotechnology from the University of Georgia in May 2010. She arrived at Purdue University in August 2011 and by-passed her M.S. degree and earned her Ph.D. in Food Science under Dr. Lisa Mauer. Her research was on the physical and chemical stability of amorphous and crystalline powders.

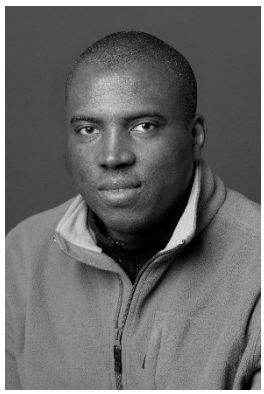
Moriah Massafaro completed her B.S. degree in Biochemistry at Purdue in 2010. She completed her Master's degree in Agronomy in 2015 with a focus on Plant Breeding and Genetics in the Weil lab. Her main project involved the mapping and identification of genetic determinants of increased protein digestibility in sorghum. The overall goal of the project was to improve sorghum as a food crop for human consumption by making it more digestible after being cooked in water.

Joel Meehl earned a B.S. in Biochemistry and Molecular Biology from Marquette University in 2001. After work and further study as a laboratory technician and in some other fields, he joined the Food Science Department as a Ph.D. student in August 2015. Co-advised by Drs. Mario Ferruzzi and Bruce Hamaker, his research focuses on phytochemical interaction with carbohydrates and the gut microbiota.

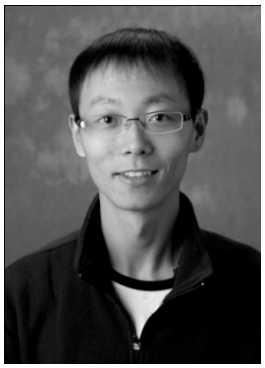
Sydney Moser earned her B.S. in Food Science from Penn State University in 2011. She continued her M.S. studies on milk protein-flavan-3-ol interactions and their impact on polyphenol bioaccessibility in Dr. Ferruzzi's lab. Following completion of her M.S. in 2013, she has continued her studies in Dr. Ferruzzi's lab. Her research now involves applying *in vitro* digestion and Caco-2 small intestinal epithelial cell models to determine the impact of fiber on polyphenol bioaccessibility and metabolism and impact of various polyphenol-rich fruits and vegetables. Additionally, her research examines the ability of polyphenols in fruits and grains to modulate glucose release during digestion and subsequent intestinal transport.

Ryan Murphy earned his B.S. in Food Science from the University of Manitoba in May 2013. He arrived at Purdue University in August 2013 with an Andrews Fellowship and is co-advised by Dr. Jones and Dr. Farkas. His research focuses on emulsion stabilization using protein and polysaccharide-based nanoparticles. Ryan intends to bypass his M.S. degree and proceed directly to a Ph.D. He interned with Kraft Foods and previously started and ran a small agribusiness focused on the production, light processing, and sale of local agricultural products.

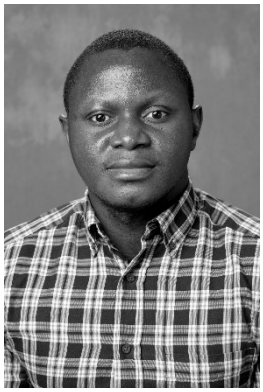
Lohit Myneedu received his Master's Degree in Food Science from JNTU - Oil Technological Research Institute, Anantapur, India. His thesis was on development of emulsion meat products from a combination of fish and chicken byproducts at the National Research Center on Meat, India. He worked in Dr. Srinivas Janaswamy's lab and graduated as a M.S. student in May 2015. His Master's research focused on understanding the structure-function relationships in kappa-carrageenan



Cheikh Ndiaye received a B.S. in Physics and Chemistry from Cheikh Anta Diop University, Dakar, Senegal). A pre-doctorate diploma in Chemistry and Biochemistry (equivalent to M.S.) was obtained from the same University in 2004. The research theme was to reduce the cooking time of millet (*P. typhoides*) and sorghum (*S. bicolor*) flours and rolled flour products (*arraw*). In 2009, a M.S. in Food Science and Technology was obtained from Jiangnan University, China with a thesis' title, "Stabilization of cloudy mango juice using pectolytic and cellulolytic enzymes". He has worked for the Institute of Food Technology (ITA) in Dakar since 2003 and is a member of the Cereals and Leguminous Vegetables Department. Recently, he joined Dr. Ferruzzi's lab after receiving a fellowship from the ERA USAID Project to study biofortification of extruded cereal products using native African plant materials as biofortification agents.



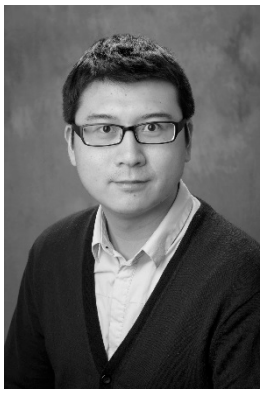
Xin Nie earned his B.S. and M.S. degrees in the Department of Chemistry from China Agricultural University, Beijing. He joined Dr. Hamaker's group as a Ph.D. student in August 2011 with support from the China Scholarship Council government scholarship. Xin's research project mainly is on dietary fiber's structure-function relationships related to colon and whole body health.



Smith G Nkhata completed his B.S. in Nutrition and Food Science from Bunda College of Agriculture, University of Malawi in 2007 in Malawi. He later joined the Government of Malawi through the Ministry of Agriculture and Food Security in 2009 as a Food and Nutrition Specialist, a post he holds up to date. In 2011 he got admitted at Michigan State University where he completed his M.S degree in Food Science in 2013. His M.S thesis was on determining how iron fortification affects the quality of dairy products. He joined Drs. Ferruzzi and Hamaker's groups in August 2015 to pursue his Ph.D. in Food Science. His research area is in part on provitamin A stability during processing, in vitro bioaccessibility and bioavailability of provitamin A from maize based products.

Gabriella Mendes Candido de Oliveira received a B.S. in Food Engineering (5 years degree) from the University of São Paulo, Brazil in 2013. She has been recipient of several scholarships from the Brazil Government and the Exchange Program between the University of São Paulo, University of Illinois, and Purdue University. In Fall 2011, she attended classes at the Food Science and Human Nutition Department, University of Illinois. In 2013 she was selected for a placement in a Ph.D. program in the United States under the program "Science Without Borders". She arrived at Purdue in Fall 2014 and her research focuses on novel processing technologies from an experimental and modeling standpoint.

Darwin Ortiz is currently a Ph.D. candidate in Food Science at Purdue University. He holds a Bachelor's degree in Chemistry from Universidad del Valle in Colombia. He has worked in the International Center for Tropical Agriculture (CIAT) where he participated in the development of the nutritional quality laboratory of CIAT. He also worked for Harvest Plus and AgroSalud Projects from 2007 to 2012. During this period, his research focused in the evaluation of bioactive compounds, antioxidant activity, and the evaluation of in vitro bioavailability of iron, zinc, protein and carotenoids. He was awarded a Fulbright Scholarship "Francisco Jose de Caldas" for his Ph.D. degree in the USA by Fulbright Colombia, and the Colombian government (Colciencias). He joined Dr. Ferruzzi's lab in 2012, where his research focuses on the evaluation of micronutrient stability during post-harvest, storage, and food processing of biofortified plant-based crops.



Xingyun Peng received his B.S. degree in Food Science and Engineering from China Agricultural University, Beijing in 2011 and his M.S. degree in Cereal, Oil and Vegetable Protein Processing from the same university in 2014. He studied protein-oil interactions in soymilk processing during his M.S. program. He began his Ph.D. at Purdue in the fall of 2014 under the direction of Dr. Yao with his research focusing on novel properties of starches associated with food applications.

Elizabeth Pletsch received her B.S. in Food Science and Human Nutrition from the University of Illinois at Champaign-Urbana in December 2011. She worked for Hillshire Brands Co. (formerly known as Sara Lee) until coming to Purdue University in August 2012. She by-passed her M.S. degree and is directly working toward earning her Ph.D. degree. She is studying under Dr. Hamaker on the physiological effects of glycemic carbohydrates.

Benjamin Redan earned a B.S. in Biochemistry from the University of Scranton, Pennsylvania in 2011. Afterwards, he received training in Cell and Molecular Biology as a post-baccalaureate fellow at the National Institutes of Health's Division of Pre-Clinical Innovation. He then joined Dr. Ferruzzi's lab in 2012 and received a fellowship through the National Science Foundation to study gut adaptation to chronic exposure of polyphenol-rich foods and beverages.

Rándol J Rodríguez obtained his B.S. Degree from the Food Science Department of Zamorano University, Honduras. In the graduate program of Food Science Department of Purdue University, he works with Dr. Yao on the structure and function of carbohydrate particulates. He is pursuing his Ph.D. Degree.

Tahrima Binte Rouf completed her B.S. in Chemical Engineering from Bangladesh University of Engineering and Technology (BUET) in 2012 in Bangladesh. After graduation, she was a lecturer in the department of Chemical Technology at Ahsanullah Institute in Bangladesh, before joining Dr. Jozef Kokini's group in August 2014. She is now pursuing a Ph.D. degree in Food Science. Her research mainly focuses on the functionalization of biopolymer using different nano-materials.

Juan Sanchez is pursuing an M.S. in Food Science with the support of the Industry Fellows program and a Ross Fellowship from the Purdue Graduate School. He graduated from Dartmouth College in 2013 with a double major in chemistry and history. Juan studies water-solid interactions and their effects on the chemical degradation of ascorbic acid in the amorphous solid state.

Leigh C.R. Schmidt earned her B.S. Food Science from Purdue in 2003 and her M.S. in Food Science from UC Davis in 2009. She joined Dr. Hamaker's lab group in August 2013 to begin her doctoral work as a USDA National Needs fellow for Foods and Health. Between degrees, Leigh worked in the food industry in quality and product development roles. Her research is on food protein matrices as a method to slow starch digestion.

Ana Steen received her B.S. in Chemical Engineering from Bucknell University. She began her M.S. in August of 2013 co-advised by Drs. Campanella and Hamaker. Her research was on a delivery system consisting of a food-based nanoscale, soft particle. Ana had an internship at Cargill during the summer of 2014 focusing on characterization of biomaterials through tensiometry and rheology. In addition to her experience with rheology, through her research Ana has acquired experience in chromatographic methods to characterize and separate macromolecules, microscopy techniques (e.g. TEM), and lately physicochemical methods to characterize biopolymers, specifically dynamic laser scattering. She finished her Master's thesis in August 2015 and now is working as Application Technologist at FONA International in Chicago.

Pablo Torres-Aguilar received his M.S. in Nutritional Sciences from the University of Illinois at Urbana-Champaign where his research focused on food insecurity and the impact of environmental factors on the diet of underserved groups, both in the US and internationally. He joined Dr. Hamaker's group in the fall of 2014 and is currently working towards his Ph.D. degree.

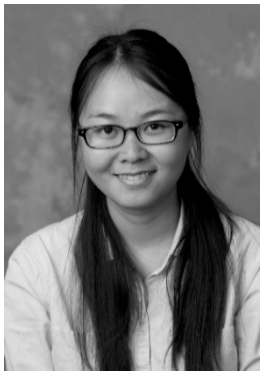
Seda Arioglu Tuncil received her B.S. in Food Engineering Department at Ataturk University in Turkey in 2010. She was awarded a scholarship for her M.S. and Ph.D. degrees in the USA by the Turkish Government and joined Dr. Mauer's lab in January 2013 for her M.S. studies. Her current project mainly focuses on the crystallization inhibitor properties of different polymers in bioactive amorphous solid dispersions. She completed her M.S. degree in December 2014 and is now working towards her Ph.D.

Yunus Emre Tuncil got his B.S. in Food Engineering at Ataturk University in Turkey in 2008. He was awarded a scholarship for his M.S. and Ph.D. degree in the USA by the Turkish Government. He joined Texas A&M University Food Science and Technology Department as a M.S. student in 2010 in where he studied on the effects of wheat proteins on dough rheological properties. He arrived at Purdue University in August 2012 in pursuit of a Ph.D. and is advised by Dr. Hamaker. His research focuses on dietary fiber structures and their effect on the colon microbiota health. He works on a collaborative project with Dr. Eric Martens at University of Michigan Medical School.

Hazal Turasan completed her B.S. degree in Food Engineering in Middle East Technical University in 2011 in Turkey. She also completed her M.S. degree in the same department in which she focused on encapsulation of rosemary essential oil. After receiving Fulbright Scholarship in 2014 she joined Dr. Jozef Kokini's group for her Ph.D. studies. Her Ph.D. research focuses on characterization of proteins.

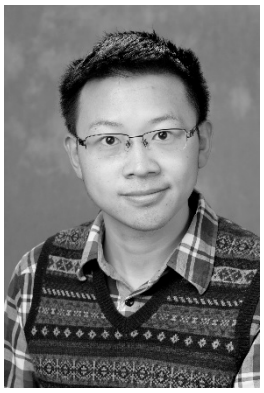
Xi Wu earned her B.S. degree in the Department of Applied Chemistry from China Agricultural University, Beijing in July 2011. She joined Dr. Narsimhan's group in January 2012 to pursue a Ph.D. degree in the Department of Agricultural and Biological Engineering and is working on investigation of pore formation in cell membrane by synthetic antimicrobial peptides.

Ying Xie received her M. S. degree in Processing and Storage of Agriculture Products from China Agricultural University, Beijing. She joined Dr. Yao's group and started her Ph. D. study in August 2012. Her Ph.D. research focuses on modified carbohydrate particulates and their functional properties, with potential applications in food and pharmaceutical areas.

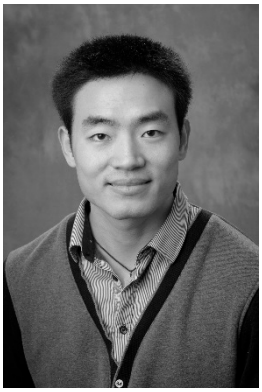


Ning Xiang earned her B.E. degree from the Department of Food Engineering of Hunan Agricultural University in July 2011. She obtained her M.S. degree from the Department of Food Science of Wageningen University in the Netherlands in June 2013. The research topic of her M.S study was "The relation between structure of globular proteins and their cross-linking activity with microbial transglutaminase". She joined Dr. Narsimhan's group as a visiting student in July 2013 to study the function of homogenization on soy β-conglycinin and pectin stabilized encapsulation system. She is continuing her Ph.D. under Dr. Narsimhan with the research topic on pore formation in lipid bilayers by antimicrobial peptides.

Ximena Yepez received a B.S. degree in Food Engineering from 'Escuela Politecnica del Litoral' Guayaquil, Ecuador. In 2012, she joined the Food Technology and Development Laboratory under Dr. Keener in the Department of Food Science. She focused on the effect of high voltage atmospheric cold plasma (HVACP) treatment in modifying vegetable oil chemistry. She obtained her M.S. degree in Food Science from Purdue University in 2014. She joined Dr. Kokini's research laboratory in Food Science where her research is focused on the study of HVACP as a catalyst in chemical reactions with the goal of defending her Ph.D. in December 2017.



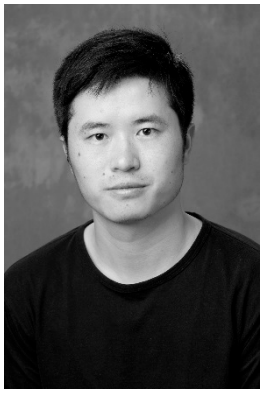
Tianming Yao obtained his Bachelor degree in Food Science and Technology from Shanghai Jiao Tong University, China. His undergraduate research focused on the OSA modification of small granule starches. He joined Dr. Srinivas Janaswamy's group in August 2015 as a Master's student with support from China Scholarship Council (CSC). His research focuses on the interaction between polyphenols and starches.



Xiaowei Zhang received both his B.S. and M.S. degrees from the Department of Food Science and Engineering from Shanghai Jiao Tong University, China. He joined Dr. Hamaker's group as a Ph.D. student in August 2014. Xiaowei's research project focuses on dietary fiber's structure-function relationships with the colon microbiota and relationship with health.

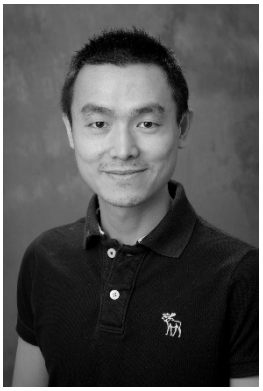
Ph.D. Post-Doctoral Research Associates

Mohammad Chegeni completed his B.S. in Biology from Ferdowsi University in 2002 in Iran. After that, he completed his M.S. degree in Public Health at Ball State University. He joined Dr. Hamaker's group on January 2010 and successfully defended his Ph.D. in December 2014. His Ph.D. research focused on maltose sensing of the small intestine enterocytes and sucrase-isomaltase maturation and trafficking. He has continued in B. Hamaker's lab as a post-doc.



Cheng Li joined Dr. Hamaker's group as Postdoctoral Research Fellow in December 2015. His research is on understanding starch source differences in fine and granular structures that lead to improved slowly digestible property in breads and cakes. Before moving to Purdue, he finished his B.S. in Biotechnology from Northwest A&F University in 2011 in China. After that, he completed his Ph.D. in July 2015in Agricultural Biotechnology at the University of Queensland under the advisement of Prof. Robert Gilbert, and worked on developing transgenic rice plants with improved starch structure that is slower digestible.

David Huizinga earned his B.S. in Biology from Purdue University in 1994, after which he worked in software quality assurance for several years. He completed his Ph.D. from Purdue in 2009, studying the effect of protein prenylation on abscisic acid signaling in arabidopsis. He then worked for Dow AgroSciences for 3 years, characterizing zinc finger nuclease expression in plants. He joined the Weil laboratory in September 2014 as a post-doc where his project is the mapping and eventual cloning of genes that control carbon partitioning in maize using SNP microarray and NextGen sequencing approaches.

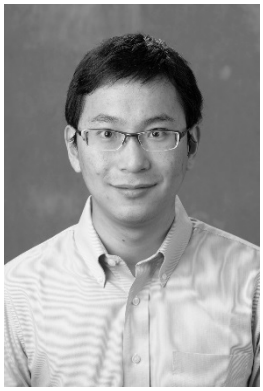


Min Li received his B.S. in Ecology from Xiamen University in 2006. His M.S. was obtained from Xiamen University with dissertation work on characterization of plant polyphenols. In 2009, he continued his Ph.D. studies on plant polyphenols in Miami University (Oxford, Ohio). Under the guidance of Dr. Ann Hagerman, Min focused on characterizing interactions between plasma proteins and green tea polyphenols. He characterized the binding interaction between serum albumin and epigallocatechin gallate (EGCg), and discovered the restorative effect of EGCg on serum albumin that was severely modified by glucose-induced glycation. Min joined Dr. Ferruzzi's lab in September 2014. His project is to characterize interactions between grain bioactives, including phenolics and carotenoids, with a specific aim to explore impacts of whole grain bioactives on starch digestion, glucose uptake and the ability to modulate inflammatory stress in gut model systems.

Bhavesh Patel received a B.S. degree in Dairy Technology from Gujarat Agricultural University, Anand, India and a M.S. degree in Food Technology from Central Food Technological Research Institute (CFTRI), Mysore, India. His Ph.D. in Food Science is from Pennsylvania State University where his research involved study of starch and polysaccharide structures, and effect of processing conditions on thermal and physical properties. Bhavesh joined Drs. Campanella and Hamaker's groups in 2008 and has worked on the development of processes for isolation of corn fiber polysaccharides and enhancing of their functional properties, and has worked on fiber rheology and incorporation into processed foods and gel formation kinetics. Dr. Patel worked on a project related to enzymatic conversion of complex polysaccharides into useful industrial and food products. Currently he is working on an industrial project related to the optimization of vegetable processing

María Julia Spotti obtained her B.S. Degree in Biotechnology from National University of Litoral in 2008 in Argentina. In 2013 she completed her Ph. D. degree in Chemistry in the Food Technology Institute of the same university, and continued her work as a post-doc for two years where she spent her second year with Dr. Campanella. Her research was on functional properties of protein-polysaccharides conjugates. She joined Dr. Jones' group on July 2015. Now she is working on solubilization and interaction between polysaccharides in aqueous solutions.

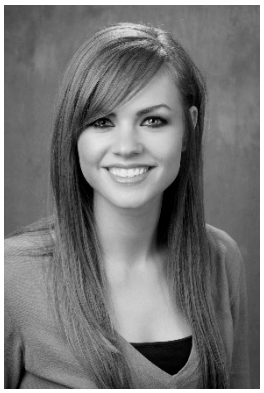
Alpana Thorat received Bachelor of Pharmacy from Pune University in 2006, and Masters of Technology in Pharmaceutical Technology- Biotechnology from National Institute of Pharmaceutical Education and Research (NIPER Mohali, India) in 2008. She worked in the pharmaceutical industry for one year (Senior Research Chemist in Sai Life Sciences, Pune-India). In 2010 she joined Ph.D. program in Chemical Engineering discipline at the Indian Institute of Technology, Gandhinagar, India. Her thesis work was on crystallization and polymorphism of curcumin. She joined Dr. Mauer's Lab (jointly working with Dr. Taylor from IPPH Purdue University) in September 2015 as a visiting scholar.



Bin Zhang joined Dr. Hamaker's group as Post-doctoral Research Fellow in February 2015. His research is on dietary fiber, colon microbiota and human health. Before moving to Purdue, he finished his Ph.D. in Food Science and Nutrition at the University of Queensland under the advisement of Prof. Mike Gidley, and worked on molecular organization, digestion and physical properties of low-order starch matrices such as granule 'ghosts' and starch extrudates.

Ozlem Duvarci has her B.Sc. in Chemical Engineering, M.Sc. in Materials Science and Engineering and Ph.D. in Chemical Engineering. She was a post-doctoral associate position under Prof. Kokini at Purdue University. Her research interest was on rheological behavior of suspensions, emulsions and biopolymers. Her current research includes large deformation rheological behavior of food products and interpretation of the rheological data to reveal the structural changes within the material experienced during flow.

WHISTLER CENTER STAFF



Mikaela Allan began working in the Whistler Center during the fall of 2014 assisting with the annual Short Course and Research Focus Meeting. She is now the current Administrative Coordinator. Mikaela graduated from Washington State University in May 2012 with a B.S. in Food Science and received her M.S. degree in Food Science in August of 2014 from Purdue University.

Anton Terekhov joined Dr. Reuhs' group as a Research Assistant in 2005. He is proficient in analytical chemistry, molecular biology techniques and analytical instruments such as NMR, GCMS, LCMS and FTIR. Anton has seven years of experience in an interdisciplinary laboratory environment including the fields of analytical chemistry, microbiology, genetics, geology, chemical and civil engineering.

PROJECT SUMMARIES

1. Impacts of Hydrocolloids on the Properties of Normal and Waxy Corn Starch

P.I.: J. BeMiller

Researchers: Li Guo, Visiting Scientist; Zhen Fu, Visiting Scientist

Objective: 1) To determine how hydrocolloids change the pasting, paste, and gel properties of a starch, 2) To define the effects of different hydrocolloids on different starches (with and without amylose, native and modified), 3) To establish a rational basis for selecting combinations of a native or modified food starch and a hydrocolloid for food use.

Progress: The following starches were used in the study: normal maize/corn starch (I), normal corn starch cross-linked with $POCl_3$ (2 levels) (II), normal corn starch cross-linked with epichlorohydrin (2 levels) (III), hydroxypropylated (2 levels) normal corn starch (IV), waxy maize starch (V), waxy maize starch cross-linked with $POCl_3$ (2 levels) (VI), waxy maize starch cross-linked with epichlorohydrin (2 levels) (VII), hydroxypropylated (2 levels) waxy maize starch. Each of the 14 starches were cooked (either in an RVA or a water bath) with water and the following 14 solutions: xanthan, xanthan in 1% NaCl, guar gum, CMC, sodium alginate, methylcellulose, HPMC, kappa-type carrageenan, iota-type carrageenan, lambda-type carrageenan, poly(ethylene glycol), sodium nitrate, sodium sulfate, sodium citrate. The following values have been determined for the cooked starch-hydrocolloid combinations: peak, trough and final viscosities, breakdown and setback (RVA) of I, II, III, V, VI and VII; G´, G´´, tan δ and η* after storage of the pastes at 4 °C for 0, 2, 4 and 6 days for I, II, III, V, VI and VII; swelling power, dissolved amylose and total starch dissolved after heating starch suspensions at 65, 75 and 85 °C for I, II and III; rates of retrogradation after heating to 100 °C of IV and VIII.

Underway: Data collection is complete, except for a few points that need to be double checked. Data is being analyzed for indications of the mechanism(s) involved, and manuscript preparation is underway.

Status: Active.

2. Physical Chemistry of Colloidal-Nanoparticle Interactions

P.I.: O. Campanella

Researcher: Necla Mine Eren, Ph.D. Student

Collaborator: O. Jones

Objectives: The main objective of this research was to develop a design paradigm to engage the nano-bio hybridization/complexation of macromolecules into the macro-structure/rheology manipulation. Specifically, supra-colloidal assembly of disordered fractal microstructures was studied with two complementary approaches.

Progress: Rheological attributes of bio-polymer nanoparticle interactions were investigated using dynamic light scattering and rheology. Concentrated nano-structured suspensions of silica and α-lactalbumin were formed under different electrostatic conditions by changing the suspension pH. Electrostatic interactions were shown to significantly affect the rheological characteristics of the suspensions. Changes in the rheological behavior was indirectly attributed to attraction and repulsion between the inorganic (silica) and organic component (protein) of the suspension. Specifically, perturbation of short range interactions, protein bridging and silica re-dispersion were proposed to play the key roles in the macro-structure formation. Possibility of tuning the rheological characteristic of nano-structured suspension was directly attributed to the formation of disordered fractal microstructures under the influence of electrostatic interactions.

The thermodynamic nature of complexation at the silica nanoparticles with protein (lysozyme) was investigated with isothermal titration calorimetry (ITC) and circular dichroism. A new model was developed to quantitatively asses the complexation induced by the protein adsorption. Formation of disordered aggregates complexation shows a bimodal character due to two distinct binding modes: a higher affinity binding mode that is driven by a larger entropic contribution is followed by (2) a low affinity binding mode that is a consequence of moderate enthalpy and entropic contributions. Overall dominating contribution of entropy showed the case that, the assembly of supra-colloidal microstructures by using nano-particles and biopolymers as building units is not

limited by unfavorable enthalpic restrictions and instead could be achieved by entropic pathways.

Status: Completed, several manuscripts published.

3. A Soluble Self-Assembling Nanoparticle from Starch, Protein, and Lipid for Healthy Nutrient and Other Hydrophobic Compound Delivery

P.I.s: O. Campanella, B. Hamaker

Researcher: Ana Steen, M.S. Student

Objective: The overall goal of the current research is to scale up lab production of our previously researched soft nano-sized particle to increase yield while maintaining control over particle parameters such as size and shape. One parameter that has been investigated is cooling rate during formation. Differential scanning calorimetry was used to determine thermodynamic stability of particles formed under different cooling conditions. Size exclusion chromatography using refractive index (RI) and multi-angle laser scattering (MALS) detectors were used to evaluate changes in nanoparticle molecular weight and size.

Progress: Previously discovered starch-protein-lipid nanoparticles, with the potential to encapsulate sparingly soluble, small molecules were found to form rapidly after the addition of linoleic acid at temperatures as low as 25˚C as determined by rheological analysis, high performance size exclusion chromatograph (HPSEC) and transmission electron microscopy (TEM). Properties of these particles were not affected by variations in temperature profile during processing for temperatures below 69˚C as determined from viscosity curves and rheological analysis. These combined results illustrate that the characteristic, cooling stage viscosity peak occurring during formation of nanoparticles is not an indication of nanoparticle assembly onset. Formation of nanoparticles occurs earlier during processing, independent of temperature. These findings show the potential to decrease processing steps and encapsulate heat labile bioactives.

Status: Completed, one manuscript to be submitted.

4. Industrial Processing Properties of Tomato Products

P.I.s: O. Campanella, B. Reuhs, O. Jones

Researcher: Xing Fei, Ph.D. Student

Collaborators: A. Handa (Department of Horticulture, Purdue University), Cintya Hitomi Syozi, He Liu, Zhu, Danshi Zhu

Objectives: This project is a continuation of past work and is aimed to optimize processing of tomato products to impact product quality, specifically viscosity. It is focused on the characterization of tomato products components that have an impact on their viscosity.

Progress: Xing's research focuses on the structural and chemical properties of plant cell wall material, and he tries to link these properties with the rheological properties of foods derived from plant cell wall material. These plant cell wall derived products can be considered as suspensions in an aqueous medium. His research is determining effects such as soluble pectin, particle properties and processing conditions on the rheology of tomato suspensions. He has found that soluble pectin has only a limited effect on the viscosity of suspensions whereas particle concentration was the dominant factor which could be related to the rheology of tomato products. Particle size showed its influence on product viscosity which could be altered by the presence of pectin. Solubilized pectin increased interparticle interaction resulting in a larger particle size. Although the viscosity of reconstituted serum was low, soluble pectin played an important role on stabilizing the suspension and increasing the interaction between particles. Research was also done with the collaboration of visiting student, Cintya Hitomi Syozi from the University of Sao Paulo, Brazil, to investigate the viscosity loss of tomato products during the concentration process. Prolonged heating produced changes in the physical properties of the tomato particles. The particle size of the suspension after tomato products were concentrated was significantly smaller than that of the original tomato products. When the concentrated tomato paste samples were diluted to the same solid content (4.0 °Brix) as original tomato products, they exhibited a significant viscosity loss. These losses were correlated with viscoelasticity (G' and G") loss of the samples that was mostly controlled by the structure and mechanical properties of the particles forming the suspension.

Status: Xing continues to study the changes of the physical and chemical properties of tomato cell wall material during processing. His work is helping to develop new approaches to produce quality tomato products. Two visiting scholars from China, Drs. Danshi Zhu and He Liu, are collaborating in this project and their work will be reported next year.

5. Structure-Function Relationship of Highly Branched Starch

P.I.s: O. Campanella, B. Hamaker

Researcher: Fang Fang, Ph.D. Candidate

Collaborators: B. Reuhs, J. BeMiller

Objectives: 1) Understand the mechanism of shear-thickening behavior of gelatinized starch dispersions; 2) Understand the effects of hydrocolloids on the shear-thickening behavior of gelatinized starch dispersions; 3) Application of shear-thickening behavior on delay in gastric emptying time.

Progress: After gelatinization, starch dispersions usually exhibit shear-thinning behavior; however, we have observed that gelatinized waxy corn and potato starch dispersions exhibit shear-thickening behavior at shear rates around 20 s^{-1}, a phenomenon that was is observed in gelatinized waxy wheat and rice starch dispersions, but not in normal starches. Recent work indicated that the addition of certain hydrocolloids had a significant enhancing effect on this shear-thickening behavior. With addition of agar and xanthan gum, the shear-thickening behavior disappeared; but after addition of gum arabic, the shear-thickening behavior moved to higher shear rate and was more obvious. With addition of guar gum, pectin and sodium alginate, shear-thickening behavior didn't change much. The relationship between the structure of the waxy starch gelatinized suspensions alone and in the presence of gums with the rheology of their suspensions is being sought

Status: Active, two manuscripts in preparation.

6. Influence of Bubble Growth in Non-Fickian Transfer Of Mass

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

Researcher: Dongdong Ma, M.S. Student

Objectives: The main objective of this project is to describe the flow of complex viscoelastic food materials in terms of deformations existing during cereal processing, specifically at high temperatures. The developed mode incorporates swelling effects in the moisture transport equations as well as the phenomenon of the vapor bubbles growth. This enables us to overcome the limitation of previously developed models that do not account for product expansion due to vapor bubble formation. The new model describes better the resulting volume change of biomaterials during processes that leads to expansion, like for example extrusion, pellet expansion and drying. Furthermore this new model can be successfully applied to predict anomalous diffusion processes that involve the deformation of viscoelastic processes biomaterial matrices.

Progress: Drying and expansion of cereals is a critical and important process in the food industry drastically impacting the quality of the final products. Quality issues include density changes, crust formation, puffing, flavor and color development. This research deals with simulations obtained from a developed mathematical model that is able to predict changes during the processing of viscoelastic biomaterials, specifically during the drying and expansion process of cereals. A model was developed that accounts for moisture diffusion through viscoelastic materials which are deformed suring processing. The behavior of viscoelastic materials is controlled by the Deborah number, classically defined as the ratio of a relaxation time and experimental time. The material relaxation time provides an indication on the ability of the material to reach back its un-deformed/equilibrium state after is being deformed by mechanical means in a time defined as the experimental time. Viscous or liquid behavior is observed at low Deborah numbers, i.e. when the experimental time exceeds the time necessary for the material to return to its un-deformed/equilibrium. Conversely, for long Deborah numbers an elastic behavior is observed in the response of viscoelastic material to a mechanical perturbation. During processing of cereals where diffusion of water and formation of bubbles are the prevalent phenomena, the Deborah number is defined considering other times that are relevant to the deformation of the material during the formation of bubbles and the diffusion time. For the purpose of this work, viscoelastic effects and deformation of the material can be neglected when the Deborah number is small. Conversely, at high Deborah numbers, the deformation of the material and viscoelastic effects become significant and the diffusion of water during the process does not follow the Fickian model.

During this non-Fickian diffusion regime the materials have a significant moisture loss shut-off, that can be observed by the presence of a crust in the surface of material during a drying process. This crust seals the loss of the water of the sample and generating a high pressure in the material that promote bubble growth and expansion.

Results of the model has been verified by comparing results with model predictions based on typical Fickian based diffusion describing moisture transport as well as quantitative analysis involving non-Fickian diffusive processes that explain well known phenomena such as crust formation during drying. Product characteristics including thickness, moisture profile and vapor profiles were obtained at different materials properties and conditions involving both Fickian and non-Fickian diffusive processing conditions.

Status: Active.

7. Modeling Inactivation Parameters of Spore Cells Subjected to Cold Plasma and other Non-thermal Processes

P.I.: O. Campanella

Researcher: Gabriella Mendes Candido de Oliveira, Ph.D. Student

Collaborators: K. Keener, A. Garner (Nuclear Engineering)

Objectives: 1) Model inactivation parameters of *Bacillus subtilis* spores under cold plasma sterilization, 2) Build a model able to capture the varying conditions of reactive gas species and that, at the same time, is able to predict the time necessary to achieve a complete sterilization process, 3) Explore the possibility of using other non-thermal processes to process beverages in order to reach total sterility while keeping good product qualities. The use of non-thermal processes, like for example pulsed electric field (PEF) to modify the structure of plant cells is also explored.

Progress: The aim of the current project is to model inactivation of spore cells by using a probabilistic model that is more adequate to describe the different mechanisms of microbial survival curve. The rate of change of survived spores can be calculated by a mathematical model derived from the Weibull model. Empirical equations are used to describe the generation of ozone concentration over time, assuming that this reactive gas specie is the lethal agent responsible for spore inactivation in the process. Thus, with the solution of this model, it will be possible to anticipate the time necessary to achieve a complete sterilization process under conditions of non-uniform inactivation agents, ozone in this case. The system of equations defining the model are solved using the software MATLAB and the survival parameters from these simulations can be used to predict the behavior of experimental survival curves obtained at different conditions. The validation of the model done by comparing model results with experimental data was good. It is hoped that the developed model can be extended to other types of non-thermal treatment where the inactivant agent is far from being constant. In addition to cold plasma physics, the model can be applied to non-thermal treatments such as high intensity ultrasound, high pressure processing and pulsed electric fields, among others processes.

Status: Active, one manuscript in preparation.

8. Functionalization of Corn Zein for Food Applications

P.I.s: O. Campanella, B. Hamaker, J. BeMiller

Researcher: Chinmay Joglekar, Ph.D. Student

Progress: Study has begun on the decolorization/deodorization and practical functionalization of corn zein. The objective is to obtain a light colored or white zein powder product that can be used in food applications without negative impact on sensory qualities. Zein gets its yellow color predominantly from carotenoids compounds. Zein was partially decolorized by dissolving it in solution of 70% aqueous ethanol and then a liquid extraction was done using an organic solvent (hexane, as this solvent is used in the food oil extraction industry). Initial studies have been conducted on bread making using corn zein. We are in the process of testing for a standardized gluten-free bread that we will use in further experiments. The objective here is to make the zein provide chewiness to the crumb (internal) structure of the bread and increase its cohesiveness, and potentially improved loaf volume, for overall better quality than the current gluten-free products in the marketplace.

Status: Active.

9. Modeling of Gastrointestinal Bacterial Growth Influenced by Viscosity

P.I.s: O. Campanella, B. Hamaker

Researcher: Han Tao, Visiting Student

Collaborators: J. Patterson (Animal Science), E. Martens (University of Michigan Medical School)

Objectives: 1) Understand the effects of viscosity on the gastrointestinal bacterial behavior, 2) Develop mathematical models to describe growth curves and predicting inhibition and/or inactivation of microbial growth under a variety of substrates.

Progress: The aim of this work is to investigate the utility of dietary fibers (FOS or inulin) for the growth of *Bacteroides* strains in medium- and high-viscosity systems. Preliminary results show that high-viscosity systems greatly interfere with access of bacteria to substrate resulting a reduction of the bacterial growth (hypothesized to be due to a restriction of nutrient diffusion due to the high viscosity). The use of mathematical models will allow for calculation of growth rate constants at each time, and for estimating growth rate constants from early growth curve data, and developing more complete descriptions of cell proliferation.

Status: Active.

10. Molecular Dynamic (MD) Simulation of Amylose and Free Fatty Acid (Linoleic Acid)

P.I.s.: O. Campanella, B. Hamaker

Researcher: Lilin Cheng, Visiting Student

Collaborator: Xiao Zhu (Purdue ITaP Research Computing)

Objectives: 1) Understand the complexation interaction between the amylose and free fatty acid (linoleic acid) using MD simulation, and 2) To visualize how the amylose and linoleic acid molecules change during the complexation interactions.

Progress: The objective of the current project is to investigate how amylose and linoleic acid molecules change when they interact with each other using the MD simulation. Different kinds of force fields are applied in this work, i.e. all atom force field and united force field, to see which one is better. The united force field was chosen for this project. It can be seen that the linoleic acid bonds with amylose and they form helix structures during the simulation period at the room temperature.

Status: Active, one manuscript in preparation.

11. Impact of Phytochemicals on Starch Digestion and Intestinal Glucose Transport

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

Researchers: Sydney Moser, Ph.D. Student; Amber Furrer, M.S. Student; Min Li Ph.D., Post-doc.

Objective: To develop and validate in vitro/cell based gut models suitable for screening interactions between phytochemicals and starch in foods.

General: Dr. Ferruzzi's group focuses on the interactions between phytochemical constituents in foods and macronutrients (proteins and carbohydrates) as they impact phytochemical bioavailability and macronutrient availability. In these efforts they have begun to develop in vitro and cell based approaches that can be leveraged to screen foods for endpoints including phytochemical availability and glucose release and intestinal transport.

Progress: Coupled *in vitro* digestion/Caco-2 intestinal cell culture models have been adapted using a combination of brush boarder enzymes and labeled glucose (d7-glucose) to model both glucogenesis and transport through digestion. To date this has been applied to screen both phenolic-rich extracts and model food systems. In the past year we have advanced the application of this model to whole food systems and interactions between phenolic rich beverages (juices, teas and coffee) with starch rich meals. In the coming year, correlation to *in vivo* data will be prioritized.

Status: Active, manuscripts in preparation.

12. Dietary Fibers and *In Vitro* Fermentation: SCFA Production and Microbiota Changes

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

Researchers: Bin Zhang, Post-doc; Tingting Chen, Ph.D. Student; Xiaowei Zhang, Ph.D. Student; Thaisa Jungles, Visiting Scholar; Enosh Kazam, M.S. Student

Collaborators: A. Keshavarzian (Rush Medical School, Chicago); L. Zhao (Shanghai Jiao Tong University); C. Nagler (University of Chicago)

Objectives: Fermentable dietary fibers have the potential to produce positive short chain fatty acid (SCFA) changes in the colon, such as specific elevated levels of butyrate or propionate, and desired changes in microbiota composition through favoring of certain bacteria or bacterial groups. Our interest is in finding functional and, where possible, targeted fermentable fibers, whether soluble or insoluble, to improve gut health; and to understand their fermentative properties and effects.

Progress: Overall, our strategy with our collaborators (including E. Martens in the next summary) is to try to better understand fiber requirements of desirable bacterial groups or even individual bacteria, and to find ways to target their promotion. In one study, Thaisa Jungles set up a reverse transcriptase-qPCR procedure to monitor specific butryogenic bacteria in the Clostridium clusters XIVa and IV that are of interest towards maintaining good epithelial cell barrier function. Certain dietary fibers hypothesized to promote such bacteria were tested in and in vitro fecal fermentation system and were found to have variable effects on promotion of different butryogenic bacteria. Enosh Kazam is continuing this work towards understanding and identifying fibers with particular promotion abilities towards these and perhaps additional bacteria.

Tingting Chen has worked on a number of projects related to 1) SCFAs and their role, in mixtures and in different concentrations, on intestinal cell monolayer permeability (barrier function), 2) soluble fibers and their mixtures and fermentation properties and microbiota 16S rRNA-typed communities in healthy and diseased stools, and 3) understanding of fiber effect in individuals with different gut microbiota communities (enterotypes). She showed at certain total SCFA concentrations that butyrate in a mixture of SCFAs promotes integrity of the differentiated Caco-2 monolayer, and both in a protective and repair mode before and after insult to the monolayer with tight junction disruptive agents. In collaboration with our partners at Rush Medical School, she is examining a range of stool samples from diseased patients and testing different soluble, and mostly tolerable, fibers for SCFA production and types and microbiota compositional changes. These are ongoing studies. Lastly, with Prof. Liping Zhao we have studied the utilization of fibers in microbiota of different enterotypes. Here, we have found distinct differences in fermentation SCFA products and microbiota utilization with same fibers treatments.

Xiaowei Zhang researched the relationship of chemical structures of plant cell wall polysaccharides and their fermentative properties. He resolved the fine structure of quinoa fibers, with L. Lamothe (Ph.D. graduate in 2014), that have a novel property of low initial gas production with comparably high SCFA generation. He has on a contract research project on orange fiber and fermentation properties that will be reported next year. His current study is on cereal arabinoxylans where he is examining fermentation properties of isolated solubilized polymers and their re-crosslinked insoluble form.

Work of post-doc Bin Zhang has been funded through Nutrabiotix, a start-up company of B. Hamaker and A. Keshavarzian directed towards disorders and diseases that can be addressed with fibers. This work will be reported in the next year.

Status: Active, a number of manuscripts in preparation.

13. Dietary Fibers and Specific Actions Using Pure Strain Colon Bacteria

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

Researchers: Yunus Tuncil, Ph.D. Student; Xin Nie, Ph.D. Student; Xiao Hua, Visiting Professor

Collaborator: E. Martens (University of Michigan Medical School)

Objective: To increase our understanding of how dietary fiber structures are utilized by colonic bacteria for the purpose to develop strategies to change the gut microbiota for improved health.

Progress: With Prof. Eric Martens at University of Michigan Medical School, we work on projects to better understand the requirements and abilities individual bacteria have to access carbohydrate substrates and in competitive systems how they utilize fibers. This is done currently using *Bacteriodes* strains. Our joint goal is figure out how dietary fibers (oligosaccharides and polysaccharides) can be used to favorably affect the colon microbiota for reasons of health.

Based on previous work, Xin Nie demonstrated that nutritional relationships (e.g. cross-feeding, competition) between human gut strains (*Bacteroides*

xylanisolvens XB1A, Bacteroides ovatus 3-1-23, Bacteroides cellulosilyticus DSM 14838) are influenced by discrete dietary fiber structures, corn arabinoxylan fragments with subtle structural differences. In a multi-strain microbial community, *B. xylanisolvens XB1A* showed the capacity to support the growth of *B. ovatus 3-1-23*, which poorly digested the structurally complex fragments alone, apparently due to a cross-feeding mechanism. The support of *B. ovatus 3-1-23* by *B. xylanisolvens XB1A* was notably changed by different arabinoxylan substrates. Similarly, *Bacteroides ovatus 3-1-23* and *Bacteroides cellulosilyticus DSM 14838* showed a fiber structure-dependent ability to compete for different substrates over a two-day incubation. These subtly different arabinoxylan substrates induced notably different compositions of the model community (e.g. the abundance of *B. cellulosilyticus DSM 14838* was changed from 28% to 80% on the different substrates). qPCR was used to characterize the abundance of each strain in the community, and showed that the behavior of gut bacterial strains in a competitive environment is highly fiber structure dependent. This study indicates that the microbiota composition potentially could be changed by specific fiber structures through predictable nutritional interactions.

In a follow-up from last year, Yunus Tuncil aimed to understand the strategies of *Bacteroides ovatus* (*Bo*) and *B. thetaiotaomicron* (*Bt*) to utilize different glycans presented as a mixture, and to investigate whether these strategies are preserved when they are co-cultured. A series of time course assays were performed in which both bacteria were individually grown in a media containing six different dietary fibers of which they both were capable of degrading: amylopectin (AP), arabinan (ARAB), chondroitin sulphate (CS), pectic galactan (PG), polygalacturonic acid (PGA), and rhamnogalacturonan I (RGI). Remaining substrates were measured over time as well as gene expression profiles. Both bacteria utilized certain glycans before others, but with different priorities, supporting past work that bacterial species show species-specific hierarchical preference to glycans. Co-culturing of these organisms in the same mixture revealed that hierarchical preferences of human gut symbionts are preserved even in competitive environments. Moreover, their different glycan priorities maintain their stable coexistence for a long period of time. Additionally, a hypothesis was tested whether molecular structure of a glycan affects its place in the hierarchy. To test this, the hierarchical substrate preference test was repeated for *Bo* by substituting AP with a structurally simple starch analog [maltohexaose (MH)]. AP was used after RGI by *Bo* when AP was included in the mixture, whereas MH was used before RGI, so the utilization of RGI by Bo was delayed in the presence of MH, showing that bacteria species' preferences of a particular substrate can be changed by manipulating its chemical structure. This was paralleled by gene expression data. Such information is important to develop strategies for predicted manipulation of microbiota communities via diet for improved health.

Visiting faculty, Prof. Xiao Hua from Jiangnan University, developed new methods to make cellulose-based oligosaccharides, as well as larger hydrolyzates, and their fermentative properties were examined in certain cellulose-utilizing *Bacteroides*. These results will be reported in the next year.

Status: Active, five manuscripts in preparation.

14. Investigations on Slowly Digestible Glycemic Carbohydrates

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

Researchers: Jongbin Lim, Ph.D. Student; Leigh Schmidt, Ph.D. Student; Anna Hayes, Ph.D. Student

Collaborators: B.H. Lee (Gachon University, South Korea); A.H.M Lin (University of Idaho); M. Ferruzzi; S.H. Yoo (Sejong 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)

Objective: To design slowly digestible glycemic carbohydrates for ileal deposition of glucose in the small intestine for the purpose of testing and targeting physiologic response; and, related to ways to manipulate starch digestion rate, to better understand natural inhibitors and their effect on the four mammalian α-glucosidase enzymes.

Progress: Our current interest in glycemic carbohydrate research is to understand how to achieve slowly digestible carbohydrates that have the potential to effect physiological changes through ileal or colonic triggers to influence appetitive response and sustained energy effect. We have continued to study ways to prolong the glycemic response and to reduce the glycemic spike, but with emphasis on longer digestion times that may combine slowly digestible carbohydrate with fermentable resistant starch or hydrolyzates.

Jongbin Lim has worked with Prof. Byung-Hoo Lee to develop and refine an *in vitro* assay to assess activity of

the individual mammalian α-glucosidases, using rat intestinal enzymes, in the presence of different glycemic carbohydrate structures and inhibitors. Jongbin is further examining the relationship of the structure of phenolic compounds with inhibition properties of α-amylase. In a second study, the inhibitory effects of eight phenolic compounds were investigated and their structures examined for inhibition of α-amylase. Three phenolic structural factors were considered, 1) compounds of differing molecular weights within the same galloyl group, 2) compounds of the same molecular weight with different C-ring structures, and 3) aglycon and glycoside forms. In rank order, the highest inhibition property was observed for quercetin, followed by cyanin, EGCG, cyanidin, (-)-catechin gallate, (+)-catechin, epigallocatechin, and gallic acid. The inhibition properties of all compounds observed had a low linear relationship with their Mw (r2 = 0.313), correlation r^2 = 0.811 in the galloyl group on phenolic compounds. Quercetin (Mw: 302.24) showed higher inhibitory effect compared to epigallocatechin (Mw: 306.27) and (+)-catechin (Mw: 290.27) despite having similar Mw, and perhaps was related to the C-ring structure. Cyanin, the glycoside of cyanidin, had a 20% higher inhibition property. Moreover, the overall tendency was that the number of hydroxyl groups appeared to increase the inhibition influence of the phenolic compounds. This study provides insight on structural factors of phenolic compounds that relate to their inhibition of α-amylase activity.

Work continued in collaboration with Meric Simsek in her new role as faculty member in Turkey. With Prof. Roberto Quezada-Calvillo previous work was extended on the action of purified phenolic compounds on gene expression in intestinal enterocytes and its subsequent effect on carbohydrates.

Leigh Schmidt completed work on cereal endosperm phenolics as potential disulfide interchange mediators in polymerization of starch-associated proteins. This work focuses on understanding how slowly digestible starches might be achieved through their embedding in protein matrices that are hypothesized to be facilitated through phenolic interaction. Sorghum and corn flours contained 1.7±0.2 and 1.4±0.2 mg GAE/g for acidic methanol extracts, respectively, approximately twice that of rice (0.8±0.1). Acidifying the extraction solvents increased antioxidant activity 30-80%. Higher amounts of 3-deoxyanthocyanidins from sorghum were extracted using acidified solvents, and apigeninidin ranged from 23.3±0.5 to 94.1±7.1 μg/g, with total 3-deoxyanthocyanidin content from 3.9 to 13.1 mg Apigeninidin Equivalents/100g. Sorghum fractions demonstrated the ability to polymerize ovalbumin to a greater extent than corn masa, and rice exhibited only slight polymerization. Elucidating the role of phenolics in protein matrix formation could lead to an understanding of how to form similar matrices in food and cereal products, constraining glycemic response, and forming a delivery method for slowly digestible starch.

Anna Hayes conducted initial studies on millet agglomerated products (e.g., couscous) to understand why non-viscous millet products are shown by our studies to have a slow gastric emptying rate compared to other non-viscous starchy food products tested. This work is in progress.

Status: Active, a number of manuscripts in preparation.

15. Cellular and Physiological Response Studies of Starchy Materials with Slow Digestion Profiles

P.I.: B. Hamaker

Researchers: Mohammad Chegeni, Post-doc; Marwa El-Hindaway, Ph.D. Student; Beth Pletsch, Ph.D. Student

Collaborators: H. Naim (University of Veterinary Medicine Hannover, Germany); B. Nichols (Baylor College of Medicine, Houston

Objectives: To understand the cellular and physiological responses to slowly digestible carbohydrates that might have value in the area of controlled glycemic response, satiety, and the concept of sustained or extended energy release.

Progress: We reported last year from work done by Marwa El-Hindaway that enteroendocrine L-cells, which are found in abundance in the lower small intestine and in the colon, are more responsive to GLP-1 release for maltose compared to short chain fatty acids (SCFAs). GLP-1 is a gut incretin hormone that regulates insulin and also activates the appetite center in the brain for satiety response and influences stomach emptying rate. Further work in the past year, expanded this finding to show that higher DP maltooligosaccharides, such as maltotriose and maltotetraose, are more potent than maltose in triggering GLP-1 release from L-cells in culture and were more stimulatory than propionate. Conversely, SCFAs in initial work appear to trigger greater Peptide YY release, a gut hormone that also acts in

the hypothalamus appetite area of the brain. These new findings imply a particular sensitivity of the L-cells in the ileum of the small intestine to the maltooligosaccharide digestion of products of starch by α-amylase to triggering GLP-1. This adds to our recent work showing that slowly digestible carbohydrates, particularly starch, can actually reduce food intake, and has led us to plan further studies to develop such carbohydrates or strategies to activate this feedback system in the body.

Mohammad Chegeni, as post-doc, spent the majority of 2015 conducting a contract research project that will be reported later. Previously, we showed that small intestinal Caco-2 enterocytes sensed the maltooligosaccharide products of starch digestion and, in turn, mobilized and activated the α-glucosidases stored in those cells. This apparently is a system designed to respond to starch digestion and perhaps particularly in the distal small intestine that is not always presented with starch products to digest to glucose for enterocyte uptake. Further work by him revealed that maltooligosaccharides also stimulate cell differentiation as measured by NMR-based metabolomic analysis.

Beth Pletsch reported last year that consumption of whole grain brown rice significantly slowed gastric emptying rate, while rice varieties with moderate increase in amylose content did not. She is pursing work on understanding the basis of this finding, and to similarly explore why millet agglomerated products, in the form of couscous-type products, have slow gastric emptying. Research focus is on whole grain and particle physical properties and/or starch digestion kinetics that could slow gastric emptying rate. Our interest in gastric emptying relates to potential satiety response associated with slow gastric emptying as well as sustained energy effect.

Status: Active, a number of manuscripts in preparation.

16. Carbohydrate-Based Antimicrobial Carriers

P.I.: S. Janaswamy

Researchers: Carlos Carter, M.S. Student; Atul Singh, Post-doc (A. Bhunia's lab)

Collaborator: A. Bhunia (Food Science, Purdue)

Objective: Food quality and shelf-life affect the appearance of food products and in-turn the consumer acceptance. Owing to the perishable nature of food products, protecting them from spoilage bacteria and pathogens is important, especially during preparation, storage and distribution. Microbial growth is one of the primary reasons why food loses its quality and consequently becomes unsafe for consumption. Thus, packaging of food under a modified atmosphere coupled with storage at low temperature could be a viable approach to extend the shelf-life and prevent pathogen growth. However, these processes alone are not sufficient for reducing the foodborne outbreaks and public health concerns. Essential oils (EOs) possess antimicrobial properties but are water insoluble and prone to oxidative degradation so that higher concentrations are needed to achieve the desirable activity. This study aims at developing carriers based on carbohydrates to protect EOs from volatilization and oxidation, and to achieve maximum antimicrobial activity from EOs towards improving the food quality and shelf-life of food products.

Progress: Carvacrol and sodium iota-carrageenan (IC) were chosen as the model EO and carbohydrate, respectively. Antimicrobial activity was tested against the foodborne pathogen *Salmonella heidelberg*. Salmonella was cultured in tryptic soy broth in the presences of IC fibers encapsulated with carvacrol. The encapsulated fibers indeed slowed the growth of *Salmonella* for 24 hrs. The results suggest that carvacrol-encapsulated in IC fibers could be effective in controlling the growth of *Salmonella.*

Status: Active, available for sponsorship.

17. Biopolymer-based Nutraceutical Delivery Systems

P.I.: S. Janaswamy

Researcher: Tianming Yao, M.S. Student

Objective: Functional foods and food supplements enriched with bioactive compounds are deemed to be effective for preventing chronic diseases such as diabetes, obesity and cardio-vascular disease and promoting health benefits. The efficacy of prepared products greatly relies on preserving the bioavailability of the active ingredients, and thus carriers play a critical role. Carriers not only aid in increasing the solubility of encapsulated compounds but also protect them from degradation, that significantly limit their activity and potential benefits; such as temperature, oxygen and light encountered

during processing and storage as well as in the gastrointestinal tract. Towards this end, our research approach is to entrap bioactive compounds in the crystalline polysaccharide networks so as to protect from external stresses as well as improve their bioavailability during delivery.

Progress: We have examined the role of water networks of potato, cassava, high amylose maize starches and waxy maize as well as sodium iota-carrageenan fibers. The encapsulation efficiency and release of curcumin and resveratrol have been studied. Results suggest that raw starch digestibility is altered upon encapsulation, especially for those possessing B-starch water networks. In the case of iota-carrageenan, one month of complexation is found to be the optimal time. Interestingly, the release profiles of curcumin and resveratrol are different. Curcumin adapts the Korsmeyer-Peppas release nature, while resveratrol follows the Makoid-Banakar model during the first 40 mins and then Korsmeyer-Peppas up to 60 mins and later saturates. These results clearly suggest the binding strength differences among the curcumin and resveratrol with the iota-carrageenan and starch networks.

Status: Active, available for sponsorship.

18. Amyloid-Like Protein Fibril Networks within Polysaccharide Composite Films

P.I.s: O. Jones, O. Campanella

Researcher: Jay Gilbert, Ph.D. Student

Objective: Identify structural and mechanical attributes of protein fibrils alone or within composite polysaccharide-based films that contribute to improved macro-scale behavior. As a secondary objective, this project seeks to establish a fundamental framework detailing the contributions of both mechanical properties and architecture among fibrous structures to the ultimate macro-scale behavior of composite materials.

Progress: Initial experiments have demonstrated the capability of forming pure and methylcellulose-composite films with protein fibrils. Fibrils stabilized by polysaccharide or food-grade polymers were used to prepare films, which showed equal or superior physical properties to cellulose films. Multifrequency atomic force microscopy methods were used to characterize the mechanical behavior of protein fibrils and cellulose within pure and composite films; results and currently being validated using commercially-available, comparable techniques. Work has begun on the investigation of composite films for the support and growth of living cells, in collaboration with a university in Australia.

Status: Active. Multiple manuscripts in preparation.

19. Stabilization of Oil-in-Water Emulsions by β-Lactoglobulin Microgels

P.I.: O. Jones

Researchers: Ryan Murphy, M.S. Student (current); Laura Zimmerer, M.S. Student (prior)

Objective Determine the interfacial activity and physical stability of oil-in-water aqueous emulsions using (a) microgels of β-lactoglobulin with or without pectin or (b) nanoparticles of zein; determine influence of particle size, particle swelling ratio, and environmental conditions on interfacial properties.

Progress: Previous research in this area showed the capability of forming emulsions using protein microgels or nanoparticles with their physical stability significantly influenced by the properties of the protein-based structures. Research published in the past year has shown that the size of beta-lactoglobulin microgels, controlled by the pH at which they were formed, significantly alters their adsorption and viscoelastic behavior at oil-water and air-water interfaces. Findings also indicated that microgels formed at lower pH values tended to de-aggregate into smaller aggregates after adsorption to the interface, which may have a wider impact on the utilization of certain polymeric aggregates as emulsion stabilizers if this is a shared behavior of microgels. These results have been published in Journal of Colloid and Interface Science. A new study has been initiated on the control of microgel swelling and mechanical behaviors by altering the formation conditions of the microgels or by increasing internal covalent bonds in the presence of cross-linking agents.

Status: Active, two articles published.

20. Protein-Polysaccharide Block Ionomer Complexes as a Core-Shell Controlled Delivery Vehicle for Hydrophobic Bioactive Compounds

P.I.: O. Jones

Researcher: Juan Du, Ph.D. Student

Objective: Establish the assembly of block ionomer complexes from charged polysaccharides and proteins to replace surfactant-micelles as controlled delivery vehicles for bioactive compounds.

Progress: Previous work demonstrated that spherical assemblies were formed by the interaction of alpha-lactalbumin, a small whey protein, and a carboxy-methyl-dextran chain to which a poly (ethylene glycol) segment had been covalently attached. These spherical assemblies are less than 100 nanometers in diameter and were proposed to be a type of complex-coacervate core micelle structure, which has previously only been formed using synthetic polymeric systems. This work was published in Food Chemistry in 2015. A project on the interaction and potential complex-coacervate core micelle formation of poly (ethylene glycol)-modified-chitosan and alpha-lactalbumin is currently underway. This study will not only demonstrate that such assembled structures can be formed with multiple polysaccharide starting materials but also that the molecular weight of the polysaccharide, in this case controlled by chemical hydrolysis, has a significant impact on the final assembled structure.

Status: Active, one article published.

21. Physical Stability and Biodegradation of Poorly-soluble Nanoparticulate Assemblies with Potential Utility as Controlled Delivery or Texturizing Systems

P.I.: O. Jones

Researcher: Chris Cheng, Ph.D. student

Objective: Determine the formation conditions and post-formation processes that contribute to the physical dispersion and integrity of poorly-soluble protein/polysaccharide nanoparticulate assemblies, as well as the bio-accessibility of resulting components, in product-relevant storage conditions and in model conditions encountered during human consumption.

Progress: Zein nanoparticles were chosen as a model system representing a poorly-soluble protein capable of forming spherical particles of ~100 nanometer in diameter. Because of their poor dispersibility in water, a project was initiated on the stabilization of the zein nanoparticles in water using polysaccharides.

Status: Active.

22. Factors Influencing Dispersion and Solubilization of Hydrocolloids in Aqueous Solutions

P.I.s: O. Jones, O. Campanella

Researcher: M. Julia Spotti, Post-doc

Objective: Identify the physical and chemical characteristics of hydrocolloid powders that contribute to the rate of dispersion, solubilization, and ultimate functionality in aqueous solutions in the presence of cosolvents or ions.

Progress: Dispersion and solubility of a model hydrocolloid gum have been followed in aqueous solution with added ion or a common cosolvent using chemical and rheological techniques. Results indicated significantly varying behaviors within the first 24 hours of dispersion depending on the initial concentration and technique of dispersion.

Status: Active.

23. Large Amplitude Oscillatory Rheological Properties of Soft and Hard Wheat Flour Doughs

P.I.: J. Kokini

Researchers: Ozlem Duvarci, Visiting Scientist; Gamze Yazar, Visiting Scholar; Jose Bonilla, Ph.D. Student; Menglu Gao, Ph.D. Student

Objective: To study the non-linear properties which are highly relevant to high shear processing of doughs.

Progress: In processing of food materials, they are usually subjected to large and sudden deformations. The latest approaches on nonlinear oscillatory

deformation enable us a deeper understanding on the rheological behavior of food materials. Non-linear oscillatory shear flow (LAOS) on hard and soft wheat was investigated to reveal the structural changes experienced by these materials and the differences in rheological behavior. Hard and soft dough showed strain hardening and shear thinning behavior in a nonlinear region with different extension which cannot be detected by steady shear and small oscillatory shear flows. It is possible to differentiate the rheological behaviors of similar but different structures like hard dough and soft dough. Our results showed that the elastic component of the hard wheat flour dough was more affected by mixing than the viscous component at all applied frequencies. In addition, the nonlinear rheological behavior of hard wheat flour dough was simulated, and the model was able to fit the data we obtained.

Status: Active.

24. Development of Biodegradable Zein Matrices with Controllable Surface Properties In Order to Develop a Biodegradable Sensor Platform for Food Analytes

P.I.: J. Kokini

Researchers: Emma Barber, M.S. Student; Hazal Turasan, M.S. Student

Objective: The objective of this research is control the surface properties of zein in order to use zein films in various film and sensor applications.

Progress: Zein's unique film forming properties have made it the focal point of a number of different applications which require the use of biodegradable substances. In this project, zein is optimized to create a platform for food allergen and toxin sensing. Many different formulations are currently being tested to optimize mechanical, chemical, and surface properties of the films. Differences within the film include solvent type, plasticizer content, and crosslinking content. The platforms are being analyzed with various spectroscopic and surface techniques. The results indicate that desired mechanical properties can be achieved by changing the chemistry of the zein platforms. Also, the surface properties of the platforms can be modified accordingly.

Status: Active.

25. Zein-based Nanocomposites for Biodegradable Packaging Applications

P.I.: J. Kokini

Researchers: Tahrima Rouf, Ph.D. Student

Objective: To improve the properties of biodegradable films by adding nanostructures to improve tensile strength and permeability.

Progress: The objective of this study was to apply different engineered nano-fillers, using different fabrication techniques to produce zein-nanocomposites, and characterize the morphology, chemical composition and property changes in the obtained nanocomposite films leading to possible application biodegradable smart packaging as well as biosensors. In pursuing this objective, zein nanocomposite films were produced using a solution casting technique and some preliminary characterization experiments have been conducted with generally favorable outcomes, but more experiments need to be performed to obtain statistically significant results.

Status: Active.

26. Nanoparticulation of Edible Proteins to Develop GRAS Nano-delivery Systems

P.I.: J. Kokini

Researchers: Rohollah Sadeghi, Post-doc; Luis Maldonado, Ph.D. Student; Menglu Gao, Ph.D. Student

Objective: Manufacturing of GRAS based nano-delivery systems to encapsulate and improve bioavailability of bioactive compounds.

Progress: Nanoparticles of α-lactalbumin and ovalbumin and BSA and poly-D-lysine (PDL) were manufactured using desolvation and the coacervation methods, respectively. The effect of preparation conditions such as non-solvent/solvent ratio, temperatures and types of non-solvents, ionic strength, addition of glutaraldehyde as crosslinking agent, temperature and pH value on the size, morphology, loading capacity and structural changes of α-lactalbumin, ovalbumin and the coacervates have been fully studied. The encapsulation capacity of BSA and PDL coacervate nanoparticles was evaluated using curcumin as a model bioactive compound.

Biocompatible nanotubes were assembled with the alternate layer-by-layer technique using BSA as the positively charged biopolymer and sodium alginate as the negatively charged biopolymer. The combination of these two biopolymers led to the formation defined and stable nanotubular structures. Electrostatic interaction between BSA and sodium alginate was established by measuring their zeta potential at different pHs using dynamic light scattering. pH values around 3-4 were found to be suitable for the formation of the biocompatible nanotubes since the difference between the opposite charges was higher. Similar results have been obtained using chitosan (CHI), α-lactalbumin (LAC), and sodium alginate (ALG). The optimum pH for CHI-LAC was around 7, whereas for CHI-ALG was found to be pH 4.0. Both CHI-LAC and CHI-ALG nanotubes were formed successfully.

Status: Active.

27. Water-Solid Interactions

P.I.: L. Mauer

Researchers: Matthew Allan, Ph.D. Student; Krystin Marrs, Ph.D. Student

Objective: To investigate the 5 modes of water-solid interactions as well as their effects on the chemical and physical stability of single ingredients and multicomponent food systems.

Progress: We are investigating the fundamentals and consequences of deliquescence, absorption, and other water-solid interactions in food systems containing crystalline and/or amorphous components. In collaboration with a researcher in the Industrial and Physical Pharmacy Department, we have demonstrated that deliquescence lowering occurs in mixtures of deliquescent crystalline ingredients (e.g. sugars, salts, organic acids, vitamins, etc.) and that reaction kinetics are influenced by this deliquescence lowering. We have also demonstrated that moisture sorption in blends of crystalline and amorphous solids deviates from a simple additive model, wherein the co-formulation of crystalline and amorphous ingredients has the potential to lower both the deliquescence RH and Tg of the blend, depending on the formulation, rendering the blend of ingredients more sensitive to environmental RH than the individual ingredients. Efforts are also focused on generating RH-temperature phase diagrams of different ingredient classes. This has importance for the formulation, sequencing, blending, storage, packaging, and stability of dry ingredient mixtures and final food products.

Status: Active.

28. Amorphous Solid State Dispersion (Amorphization) of Crystalline Ingredients

P.I.: L. Mauer

Researchers: Seda Arioglu Tuncil, Ph.D. Student; Juan Sanchez, M.S. Student; Alpana Thorat, Visiting Scientist; Chunli Lei, Visiting Scientist

Objective: To manipulate the solid state structure of inherently crystalline ingredients and document the resulting effects on physical and chemical stability.

Progress: We are investigating the differences in stability and delivery traits between crystalline and amorphous forms of both poorly water soluble and highly water soluble inherently crystalline ingredients. A variety of dispersion techniques and matrices were explored to document crystallization inhibition properties of different polymers, as well as differences in solubility and stability traits between crystalline and amorphous forms of the same ingredient. In general, polymers that are capable of hydrogen bonding or ionic interactions with the target compound are better at maintaining amorphous structures during storage. Solubility enhancement was achieved when poorly water soluble crystalline compounds were stabilized in amorphous dispersions, as well as between amorphous and crystalline forms of highly water soluble ingredients. Physical and chemical stability differences between crystalline and amorphous states of a compound were monitored. Interesting insights into molecular assembly and crystalline/ amorphous behaviors were developed during these studies.

Status: Active.

29. Starch Properties in Low Moisture/Saturated Solution Environments

P.I.: L. Mauer

Researchers: Kathryn Johnson, M.S. Student; Matt Allan, Ph.D. Student

Objective: To investigate gelatinization, pasting, and other thermal properties of starch in concentrated solutions of a variety of sweeteners.

Progress: We are investigating the thermal properties of starch in the presence of a wide variety of sweeteners to establish relationships between sweetener type and structure, water activity, molecular weight, and intermolecular interactions with starch gelatinization and pasting traits.

Status: Active.

30. Identification of Antimicrobial Peptides from Soy Protein

P.I.: G. Narsimhan

Researchers: Yvonne Lyv, Ph.D. Student; Xiaoyu Wu, Post-doc

Objectives: 1) Development of methodology for identification of desirable peptide sequences from soy β-conglycinin, 2) Characterization of antimicrobial activity of selected peptide segments against *L. monocytogenesis* and *E. Coli*.

Progress: Antimicrobial peptides (AMPs) inactivate microbial cells through pore formation in cell membrane. Because of their different mode of action compared to antibiotics, AMPs can be used to replace antibiotics in human health and animal feed and immobilized on food packaging films. We developed a methodology based on mechanistic evaluation of peptide-lipid bilayer interaction to identify AMPs from soy protein. Initial screening of peptide segments from soy glycinin and β-conglycinin subunits was based on their hydrophobicity, hydrophobic moment and net charge. Out of several candidates chosen from the initial screening, two peptides satisfied the criteria for antimicrobial activity, viz. (i) lipid-peptide binding in surface state and (ii) pore formation in transmembrane state of the aggregate, as evaluated by all-atom molecular dynamics (MD) simulation. Their antimicrobial activities against Listeria monocytogenes F4244 and E.coli O157:H7 EDL933 were confirmed by bioassay. This methodology is also applicable for identification of AMPs from any protein.

Status: Active.

31. Pore Formation in DOPC/DOPG Bilayers by Antimicrobial Peptide Melittin

P.I.: G. Narsimhan

Researchers: Yuan Lyv, Ph.D. Student, Ning Xiang, Ph.D. Student

Objective: To understand the mechanism of pore formation in DOPC/DOPG bilayers by antimicrobial peptide

Progress: Antimicrobial peptides (AMP) kill microbial cells through insertion and damage/permeabilization of the cytoplasmic membranes. Since their mechanism of action differs from that of antibiotics, they could be very useful for combating drug-resistant microbes and for treatment of microbial infections. Pore formation in DOPC/DOPG bilayers by the antimicrobial peptide melittin was investigated by explicit solvent molecular dynamics (MD) simulation to mimic their permeation action on the cell membrane of microorganism. The effects of number and orientation of melittin molecules inside the lipid bilayer on the formation of a water channel (pore) was characterized. The minimum number of peptides required for pore formation is compared with the critical pore size predicted by a mathematical model based on the free energy of pore formation. The salient features of the simulation results are then compared with experimental data for pore formation as inferred from (i) leakage of fluorescent dyes (calcein, FD4 and FD20) of different molecular weights encapsulated within liposomes exposed to melittin and (ii) the antimicrobial activity of melittin against the Gram-positive bacterium *Listeria monocytogenes* as characterized by absorbance and plate count.

Status: Active.

32. Pasting Behavior of Cross Linked Starch

P.I.: G. Narsimhan

Researchers Prasuna Desam, M.S. Student; Jinsha Lee, Ph.D. Student

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

Progress: Pasting behavior of starch greatly influences the texture of a variety of food products. The annual consumption of starch in the U.S. is 3

million metric tons. Starch consumption is believed to be linked to the occurrence of diabetes and obesity. Resistant starch with lower digestibility, which may represent a solution to diabetes and obesity, is produced by modifying the starch using different extent of crosslinking. Cross linking of starch is achieved by chemical treatment and has a large influence in its pasting behavior. It is thus important to characterize the connection between the structure, composition and architecture of the starch granules and its pasting behavior in order to arrive at a rational methodology to design modified starch of desirable rate of digestion and texture. The overall goal of this investigation is to develop a predictive model for pasting behavior of starch in terms of its structure and composition. Polymer solution theories were applied to quantify the swelling of starch at different heating rates in terms of its molecular weight, second virial coefficient and granule elasticity. The extent of cross linking and the degree of ionization of waxy maize starches were varied through reaction with phosphoryl chloride of different concentrations at different pH. The molecular weight distribution and second virial coefficient were quantified using multiangle laser light scattering, and intrinsic viscosity was measured to elucidate the conformation of starch molecule. The evolution of starch granule size distribution during pasting was measured using static light scattering. Kinetics of swelling of starch granules subjected to different rates of heating were predicted using Flory-Rehner theory and the experimental granule size distributions were compared with model predictions.

Status: Active

33. High-Value Corn Starch

P.I.: C. Weil

Collaborators: L. Mauer, Y. Yao

Researcher: Sean Tague, Undergraduate Student

Objectives: Genetics and mutagenesis are used to identify and develop maize lines that produce specialized corn starches. The working hypothesis is that corn mutants can produce starch in the kernel that has some of the same properties currently obtained by chemical modification. These mutants would, therefore, reduce processing time, cost, and variability. A second objective is to screen mutants for more digestion-resistant cooked starch, and a third is to screen for more rapidly digesting starch for use as a biofuel feedstock and improved poultry feed. Large populations of mutagenized seeds have been developed in the inbred maize lines W22 and B73. The natural diversity of maize has also been examined.

Progress: We have screened ~500 families of these seed and identified mutants that slow digestion of cooked flour to a steady release that eventually reaches normal levels of overall glucose release. We have also identified lines where there is more digestion in 20 minutes than normal starch achieves in 2 hours. We have improved our digestion assay, which now couples NIR spectroscopy with a two-enzyme digestion and automated liquid handling, allowing us to control more precisely for input starch, timing and consistent mixing, with increased throughput. We now want to understand what has been altered in these lines, have identified homozygous mutants for 30 of them, and are looking at branch length distribution and differences in endosperm transcript profiles. In addition, we have identified three diverse inbred lines that have slower digestion of cooked starch and at least one inbred with more rapidly digested uncooked starch.

Status: Active.

34. Genes Controlling Starch Channelization

P.I.: C. Weil

Collaborator: J. BeMiller

Objective: In the past, in conjunction with Dr. BeMiller, we have analyzed genetic changes associated with differences in the number of channels formed in starch granules. Using the data on how much actin can be extracted from channels in these recombinant inbred lines (the Relative Degree of Channelization, or RDC), we have used association mapping techniques to identify regions likely to have genes that control channel formation. Several of these regions contain actin and tubulin genes, and genes that impact endosperm morphology. Our goal now is to test their specific roles in forming channels in maize starch granules.

Progress: The RDC between B73 and another inbred, Oh43, as well as 200 RILs derived from these inbreds have now been phenotyped in the BeMiller lab. We have performed association analyses on these RILs to identify additional genes that impact channelization.

As a tool for these studies, we made a *brittle1 brittle2* double mutant and, together with Dr. BeMiller analyzed the amyloplasts by SEM. These mutant amyloplasts appear unfilled and may lack starch entirely, facilitating the study of the cytoskeleton that surrounds them before they fill.

Status: Active.

35. Genetic Interactions That Impact Starch Quantity and Quality

P.I.: C. Weil

Researcher: Sean Tague, Undergraduate Student

Progress: This project is awaiting a new researcher. Many mutations show differences in the phenotypes they cause when they are moved into various genetic backgrounds. The starch mutants ae1, su1 and wx are being crossed to 27 highly diverse inbreds to identify interacting genes that affect starch quantity and quality, particularly phytoglycogen. We will analyze F2 of these crosses for differences in starch content and quality. Once the effects have been determined, we will use association mapping to quickly identify and isolate novel genes that alter starch characteristics.

Status: Active.

36. Genetics of Carbohydrate Transport and Partitioning in Maize

P.I.: C. Weil

Researchers: David Huizinga, Post-doc; Meghan Ahearn, Lauren Miranda, Visiting Scientists (St. Michael's College)

Progress: We have now mapped ten new mutations impacting carbohydrate transport and distribution in maize, have identified over 350 more, and have now developed F2 mapping populations for 320 of these. In summer 2015, we will map another 40 mutations for detailed analysis. In addition we are collaborating with Dr. Jenna Rickus of Purdue's Physiological Sensors group to develop fluorescent sensor measurements of sucrose levels at varying positions in field-grown plants.

Status: Active.

37. Genetics of Sugar Accumulation and Distribution in Maize and Sorghum

P.I.: C. Weil

Collaborators: N. Carpita, D. Szymanski (Purdue University), J. Adamec (University of Nebraska)

Progress: Sugar-accumulating grasses store sucrose in the vacuoles of stem (stalk) cells in preparation for remobilizing that sugar to developing seeds. In grasses such as sugarcane and sweet sorghum, that remobilization is reduced, and the stalks are harvested to collect the sugar. In maize, remobilization to the developing ear has been selected for as a part of the domestication process, and is under genetic control. Some tropical maize varieties flower late in temperate climates and do not make ears (although they still set seed normally under shorter day lengths in the tropics). Some of these continue to accumulate sugar as though they were going to make ears while others do not; we are trying to understand and make use of this variation. In the past year, we have mapped two QTL that impact sugar accumulation in maize stalks. The next steps will be to determine the genes underlying these QTL. The focus is on increasing the processes loading sugar into the vacuoles of stalk cells and decreasing its remobilization out of those vacuoles. In addition, we are now in the fourth generation of breeding tropical maize varieties to increase a combination of biomass and sugar content.

Status: Active.

38. Analysis of Sorghum Genes Involved in Carbohydrate Metabolism and Production

P.I.: C. Weil

Researchers: J. Anderson, Student; Moriah Massafaro, M.S. Student

Collaborators: M. Tuinstra, B. Dilkes (Departments of Agronomy and Horticulture, Purdue), Charles Addo-Quaye, Eric Danquah, Hamadou Traore (INERA, Burkina Faso).

Objective: Characterization of a large mutagenized population of *Sorghum bicolor* and identification/ characterization of genes and gene functions.

Progress: We have now developed and begun to characterize one of the largest mutagenized

populations of *Sorghum bicolor* in the world. Based on our preliminary DNA sequencing of genomes from these lines, this population of 12,000 mutants (made in the genome-sequenced inbred BTx623) contains approximately 3.6 million single-base DNA changes that are predicted to alter protein coding sequences. An estimated 120,000 of these are predicted to have dramatic effect on the protein produced by the affected gene. We are screening the population for improved digestibility of the cooked starch and protein, and have identified a series of candidate mutants and demonstrated that the changes are heritable. These lines have had their genomes resequenced, and the mutations are now available as a public, searchable database, including all those in starch biosynthetic genes. We have also identified several mutant lines that have altered carbon partitioning, altered protein digestibility and improved forage quality. Initially this project was also a collaboration with researchers in Ghana and Burkina Faso. We have now obtained additional resources to expand those efforts into Niger and Senegal. We are looking for partners to help us develop these materials into food products for these African and other markets.

Status: Active.

39. Pathogen Biofilm Formation on Food Surface and its Impact on the Efficacy of Antimicrobial Compounds

P.I.s: Y. Yao, A. Bhunia (Department of Food Science), A. Deering (Department of Food Science)

Researchers: Yezhi Fu, Visiting Scientist

Objective: To study the formation and reduction of pathogenic bacteria biofilm at food surface

Progress: Biofilm formation by various pathogenic bacteria on food surface has been a major food safety issue. In this study, the ability of selected pathogens to form biofilm on fresh produce, such as cantaloupe is documented. *Listeria monocytogenes*, *Salmonella* Typhimurium, and *E. coli O157* are used as model pathogens for characterizing the formation of biofilms. The biofilms are observed using cryo-scanning electron microscopy (Cryo-SEM) over 2 - 48 h of incubation. Results obtained indicated that these pathogens were capable of biofilm formation on cantaloupe rind surface. Furthermore, when treating the inoculated cantaloupe rind with lauroyl arginate ethyl (LAE), an antimicrobial compound for food uses, the changes in the number of viable cells of different bacteria were quite different. The results indicated that *Listeria* and *Salmonella* biofilms on the cantaloupe surface had different impact on the efficacy of LAE, and it remains a challenge to effectively reduce the bacterial load at the surface of fresh produce. Based on the outcome of this study, we are exploring effective methods to enhance the efficacy of antimicrobial compounds against pathogenic biofilms.

Status: Active.

40. Synergistic Effects among Antimicrobial Compounds to Inhibit Pathogenic Bacteria

P.I.s: Y. Yao, A. Bhunia (Department of Food Science)

Researcher: Yezhi Fu, Visiting Scholar

Objectives: To evaluate the synergistic effects among synthetic and naturally occurring antimicrobial compounds against food pathogens.

Progress: Synergistic effects among antimicrobial compounds not only reduce the total amount (and cost) of active compounds needed to achieve targeted reduction of microbial load, but also create new potentials for industrial applications. In this project, a number of antimicrobial compounds are either simply mixed or combined in carbohydrate-based colloidal systems (as carriers), and their efficacies to inhibit the model pathogens are evaluated. The model pathogens include *Listeria monocytogenes*, *Salmonella*, and *E. coli O157*. Once the basic understanding is established, the formulations will be applied to real food systems, such as deli meat and fresh and fresh-cut produce, to test their protective effects against food pathogens.

Status: Active.

41. Carbohydrate-Based Biomaterials to Improve the Solubility of Active Pharmaceutical Ingredients (API)

PI: Y. Yao

Researchers: Ying Xie, Ph.D. Student

Objective: To improve the water solubility of APIs.

Progress: It is estimated that roughly 40% of new drug molecules present drug delivery challenges due to their low solubility. The Biopharmaceutics Classification System (BCS) was developed as a

systematic approach to classify Active Pharmaceutical Ingredients (APIs) based on their solubility and permeability. Based on the BCS, drug solubilization is necessary for the delivery of APIs of Class II (low solubility, high permeability) and Class IV (low solubility, low permeability). In particular, for compounds in Class II, solubilization technologies can solve the drug delivery problem. In this project, a number of carbohydrate-based biomaterials have been prepared and tested using model APIs. Results showed that both the stability and solubility of APIs can be improved through complexation with carbohydrate biomaterials.

Status: Active.

42. High-throughput Screening of Starch and Phenolic Compounds of Cereal Grains

P.I.s: Y. Yao, C. Weil, B. Hamaker

Researcher: Lingxiao Gong, Visiting Scientist; Laura Arango, Visiting Scientist

Objective: To establish an analytical platform for high-throughput screening of starch and phenolic compounds for individual corn kernels (and possibly other cereal grains)

Progress: "Clean label" for starch, a major food ingredient, not only demands technology innovations, but also the advancement of science at the interface of food chemistry, genetics and genomics, and high-throughput analysis. The overall hypothesis is that the large populations of cereal seeds subjected to mutagenesis are feasible pools for screening high-value traits related to starch and nutrients. Specifically, this project targets the establishment of a high-throughput screening platform for corn seeds. There are two primary targets for screening: (1) starch with enhanced processing and storage stabilities, and (2) individual kernels with enhanced amounts of phenolic compounds. The single-kernel screening (SKS) technique is employed to sample and analyze each kernel without affecting its vitality as seed once later planting is needed to identify its genotype for both fundamental studies and breeding programs. Currently, a microplate-based microanalysis has been generated to compare starch gelatinization and resistance to shear – properties that are closely associated with the stability of starch in food processing. A number of commercial cross-linked or stabilized starches are used as benchmarks. Concurrently, the content of phenolic compounds of individual kernels are quantified, also using a newly established, microplate-based technique.

Status: Active.

PUBLICATIONS AND OTHER SCHOLARLY ACTIVITIES

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

BeMiller

1. **Z. Fu,** S.-J. Luo, **J.N. BeMiller**, W. Liu, C.-M. Liu. Effect of high-speed jet on flow behavior, retrogradation, and molecular weight of rice starch. *Carbohydrate Polymers* 133:61-66.

2. **J.N. BeMiller,** K.C. Huber. Physical modification of food starch functionalities. *Annual Review of Food Science and Technology* 6:19-69.

3. **Z. Fu,** S.-J. Luo, **J.N. BeMiller**, W. Liu, C.-M. Liu. Influence of high-speed jet on solubility, rheological properties, morphology and crystalline structure of rice starch. *Starch/Staerke* 67:595-603.

4. Z. Sui, K.C. Huber, **J.N. BeMiller.** Effects of the order of addition of reagents and alkali on modification of wheat starches. *Carbohydrate Polymers* 125:180-188.

Campanella

5. J. Kahn, **N.M. Eren, O.H. Campanella**, S. L. Voytik-Harbin, J. L. Rickus. Organic hydrogel templates for tunable mesoporous silica hybrid materials. *MRS Proceedings* 1721: DOI: 10.1557/opl.2015.38.

6. L. Wang, **O.H. Campanella, B. Patel,** L. X. Lu. Preparation and sealing processing of sodium alginate based blending film. *Mathematical Problems in Engineering* DOI: 10.1155/2015/895637.

7. M.I. Klein, G. Hwang, P.H.S. Santos, **O.H. Campanella,** H. Koo. Streptococcus mutans-derived extracellular matrix in cariogenic oral biofilms. *Frontiers in Cellular and Infection Microbiology* 5: DOI: 10.3389/fcimb.2015.00010.

8. T. Feng, M.M. Li, J.J. Zhou, H.N. Zhuang, **F. Chen**, R. Ye, **O.H. Campanella,** Z.X. Fang. Application of molecular dynamic simulation in food carbohydrate research – a review. *Innovative Food Science & Emerging Technologies* 31:1-13.

9. **N.M. Eren,** P.H.S. Santos, **O.H. Campanella.** Mechanically modified xanthan gum: rheology and polydispersity aspects. *Carbohydrate Polymers* 134:1303-1316.

10. **O.H. Campanella**. Heat treatment. Principles and techniques. In "*Encyclopedia of Food and Health"*. Academic Press. Eds. B. Cavallero, P.M Finglas and Fidel Toldra.

11. I. Demirkesen, E. Puchulu-Campanella, S. Kelkar, **O.H. Campanella**, G**.** Sumnu, S. Sahin, S. Review Article: Production and characterization of gluten-free chestnut sourdough breads. *Quality Assurance and Safety of Crops & Foods*, http://dx.doi.org/10.3920/QAS2014.0580.

12. J.L. Kahn, **N.M. Eren**, **O.H. Campanella**, S.L. Voytik-Harbin, J.L. Rickus. Collagen-fibril matrix properties modulate the kinetics of silica polycondensation to template and direct biomineralization". *Journal of Materials Research*, Focus Issue: *Biomineralization and Biomimetics* 3:311-320.

13. **B. Patel, O.H. Campanella**. Dough processing: sheeting, shaping, flattening and rolling. in "conventional and advanced food processing technologies", pp. 51-73, S. Bhattacharya, Ed. John Wiley and Sons, Chichester PO19 8SQ, England.

See papers in **Hamaker** (Bhopatkar et al; Zhang et al.), **Jones** (Eren et al.), **Narsimhan** (Eren et al.)

Ferruzzi

14. T. Villani, **M.G. Ferruzzi,** G. Pasinetti, J. Simon, Q.-L. Wu. Chemical investigation of grape seed derived products to assess quality and adulteration. *Food Chemistry* 170:271-280.

15. B.J. Song, C. Manganais, **M.G. Ferruzzi.** Thermal degradation of green tea flavan-3-ols and formation of hetero- and homocatechin dimers in model dairy beverages. *Food Chemistry* 173:305-312.

16. J. W. Blount, **B.W. Redan, M.G. Ferruzzi, B.L. Reuhs**, B.R. Cooper, J. S. Harwood, V. Shulaev, G. Pasinetti, R. A. Dixon. Synthesis and quantitative analysis of plasma-targeted metabolites of catechin and epicatechin. *Journal of Agricultural and Food Chemistry* 63:2233-40.

17. R. Clemens, A. Drewnowski, **M.G. Ferruzzi,** C.D. Toner, D. Welland. Squeezing fact from fiction about 100% fruit juice. *Advances in Nutrition* 6:236S-243S.

18. K.K. Ho, **M.G. Ferruzzi,** A. M. Liceaga, M. F. San Martín-González. Microwave-assisted extraction of lycopene in tomato peels: effect of extraction conditions on all-trans and cis-isomer yields. *LWT-Food Science and Technology* 62:160-168.

19. D. Wang, E. M. Janle, P. J. Lachicik, B.R. Cooper, A. H. Jannasch, B.R. D'Arcy, B.A. Williams, **M.G. Ferruzzi,** G. M. Pasinetti. Role of intestinal microbiota in the generation of polyphenol derived phenolic acid mediated attenuation of Alzheimer's disease β-amyloid oligomerization. *Molecular Nutrition and Food Research* 59:1025-40.

20. D.A. Balentine, J.T. Dwyer, J. W. Erdman Jr, **M.G. Ferruzzi**, P.C. Gaine, J. M. Harnly, C.L. Kwik-Uribe. Recommendations on reporting requirements for flavonoids in research. *American Journal of Clinical Nutrition* 101:1113-25.

21. **T.R. Lipkie**, A.L. Morrow, Z. E. Jouni, R.J. McMahon, **M.G**. **Ferruzzi.** Longitudinal survey of carotenoids in human milk from China, Mexico, and the USA from the Global Exploration of Human Milk Study. *PLoS ONE* 10:e0127729.

22. J.E. Kim, S.L. Gordon, **M.G. Ferruzzi,** W.W. Campbell. Effects of egg consumption on carotenoid absorption from co-consumed, raw vegetables. *American Journal of Clinical Nutrition* 102:75-83**.**

23. T.-Y. Chen, J. Krichevsky, K. Hargett, K. Feller, R. Klobusnik, B.J. Song, B. Cooper, Z. Jouni, **M.G**. **Ferruzzi,** E. J. Janle. Plasma bioavailability and regional brain distribution of polyphenols from apple/grape seed and bilberry extracts in a young swine model. *Molecular Nutrition and Food Research* 59:2432-47.

24. W. Zhao, J. Wang, W. Bi, **M.G. Ferruzzi,** S. Yemul, D. Freirea, P. Mazzola, L. Ho, L. Dubner, G. M. Pasinetti. Novel application of brain-targeting polyphenol compounds in sleep deprivation-induced cognitive dysfunction. *Neurochemistry International* 89:191-197.

See papers in **Hamaker** (Simsek et al.), **Jones** (He et al.)

Hamaker

25. G.T. Spear, M. McKenna, A.L. Landay, H. Makinde, **B.R. Hamaker,** A. L. French, **B.-H. Lee**. Effect of pH on cleavage of glycogen by vaginal enzymes. *PLoS ONE* 10: e0132646.

26. **B.-H. Lee**, D.-W. Koh, P.R. Paul, C.-S., Park, **B.R. Hamaker**, S.-H. Yoo. Enzymatic synthesis of 2-deoxyglucose-containing maltoogliosaccharides for tracing the location of glucose absorption from starch digestion. *Carbohydrate Polymers* 132:41-49.

27. **L. A. Bello-Perez**, P.C. Flores-Silva, R.G. Ultrilla-Coello, **E. Agama-Acevedo**, **B.R. Hamaker**. In vitro starch digestibility of gluten-free spaghetti based on maize, chickpea, and unripe plantain flours. *Cereal Chemistry* 92:171-176.

28. **B.C. Porto,** P.E.D. Augusto, **A. Terekhov, B.R. Hamaker**, M. Cristianini. Effect of dynamic high pressure on technological properties of cashew tree gum (Anacardium occidentale L.). *Carbohydrate Polymers* 129:187-193.

29. **A. Chun, H.-J. Lee, B.R. Hamaker, S. Janaswamy.** Effects of ripening temperature on starch structure and gelatinization, pasting, and cooking properties in rice (*Oryza sativa*). *Journal of Agricultural and Food Chemistry* 63:3085-3093.

30. S. Peng, L. Xue, X. Leng, R. Yang, **G. Zhang, B.R. Hamaker**. Slow digestion property of octenyl succinic anhydride modified waxy maize starch in the presence of tea polyphenols. *Journal of Agricultural and Food Chemistry* 63:2820-2829.

31. C. Huang, M. Miao, **S. Janaswamy, B.R. Hamaker,** X. Li, B. Jiang. Polysaccharide modification through green technology: role of endodextranase in improving the physicochemical properties of (1→3)(1→6)-α-D-glucan. *Journal of Agricultural and Food Chemistry* 63:6450-6456.

32. **G. Zhang, L. Hasek, B.-H. Lee, B.R. Hamaker**. Gut feedback mechanisms and food intake: a physiological approach to slow carbohydrate bioavailability. *Food & Function* 6:1072-1089.

33. J. De la Rosa-Millan, A.H.-M. Lin, P. Osorio-Diaz, **E. Agama-Acevedo, B.R. Hamaker, L.A. Bello-Perez.** Influence of annealing flours from raw and pre-cooked plantain fruit on cooked starch digestion rates. *Starch/Staerke* 67:139-146.

34. **L.M. Lamothe**, S. Srichuwong, **B.L. Reuhs, B.R. Hamaker**. Quinoa (*Chenopodium quinoa* W.) and amaranth (*Amaranthus caudatus* L.) provide dietary fibers high in pectic substances and xyloglucans. *Food Chemistry* 167:490-496.

35. **P. Rumpagaporn, B.L. Reuhs, A. Kaur**, J.A. Patterson, A. Keshavarzian, **B.R. Hamaker**. Structural features of soluble cereal arabinoxylan fibers associated with a slow rate of in vitro fermentation by human fecal microbiota. *Carbohydrate Polymers* 130:191-197.

36. **M. Simsek**, R. Quezada-Calvillo, **M.G. Ferruzzi**, B.L. Nichols, **B.R. Hamaker**. Dietary phenolic compounds selectively inhibit the individual subunits of maltase-glucoamylase and sucrase-isomaltase with the potential of modulating glucose release. *Journal of Agricultural and Food Chemistry* 63:3873–3879.

37. **D. Bhopatkar, T. Feng**, F. Chen, **G. Zhang**, M. Carignano, S.H. Park, H. Zhuang, **O.H. Campanella, B.R. Hamaker.** A self-assembled nanoparticle of common food constituents that carries a sparingly soluble small molecule. *Journal of Agricultural and Food Chemistry* 63:4312-4319.

38. **G. Zhang**, D. Bhopatkar, **B.R. Hamaker, O.H. Campanella**. Self-assembly of amylose, protein, and lipid as a nanoparticle carrier of hydrophobic small molecules. In: *Nanotechnology and Functional Foods*, eds. C. Sabliov, H. Chen and R. Yada, Wiley-Blackwell, Chapter 16.

39. C. Zhang, A. Yin, H. Li, R. Wang, G. Wu, J. Shen, M. Zhang, L. Wang, Y. Jour, H. Ouyang, Y. Zhang, Y. Zheng, J. Wang, X. Lv, Y. Wang, F. Zhang, B. Zeng, W. Li, F. Yan, Y. Zhao, Z., Pang, X. Zhang, H. Fu, F. Chen, N. Zhao, **B.R. Hamaker,** L. Bridgewater, D. Weinkove, K. Clement, J. Dore, E. Holmes, H. Xiao, G. Zhao, S. Yang, P. Bork, J. K. Nicholson, H. Wei, H. Tang, X. Zhang, L. Zhao. Dietary modulation of gut microbiota contribute to alleviation of both genetic and simple obesity in children. *EBioMedicine* 2:968-984.

40. **M. Benmoussa**, A. Chandrashekar, G. Ejeta, **B.R. Hamaker.** Cellular response to the high protein digestibility/high–lysine (hdhl) sorghum mutation. *Plant Science* 241: 70-77.

41. A. Keshavarzian, S. De Kivit, **B.R. Hamaker.** Screening assay for choice of prebiotic to prevent/treat gastrointestinal and systemic diseases. PCT Int. Appl. WO 2015157163 A1 20151015.

Janaswamy

42. P.J. Polowsky, **S. Janaswamy**. Hydrocolloid-based nutraceutical delivery systems: Effect of counter-ions on the encapsulation and release. *Food Hydrocolloids* 46:658-663.

See **Hamaker** paper (Huang et al; Chun et al.)

Jones

43. Z. He, J. Chen**, S.E. Moser, O.G. Jones, M.G. Ferruzzi.** Interaction of β-casein with (-)-epigallocatechin-3-gallate assayed by fluorescence quenching: effect of thermal processing temperature. *International Journal of Food Science and Technology* 51:342-348.

44. **N.M. Eren, O.G. Jones, O.H. Campanella**. Changes in the rheology of nano-structured suspensions by adsorption of the protein α-lactalbumin on the surface of silica particles. *Rheologica Acta* 54:735-744.

45. **R. Murphy,** Y.H. Cho, B. Farkas, **O.G. Jones.** Control of thermal fabrication and size of β-lactoglobulin-based microgels and their potential applications. *Journal of Colloid & Interface Science* 447:182-190.

46. **O.G. Jones.** Protein nanostructures. In: Edible Nanostructures. Eds.: Marangoni AG, Pink D. RSC Publications, Oxford, UK, pp. 69-113.

Kokini

47. S. Ansari, F. Bozkurt, **G. Yazar,** V. Ryan, A. Bhunia**, J. Kokini.** Probing the distribution of gliadin protein in dough and baked bread using conjugated quantum dots as a labeling tool. *Journal of Cereal Science* 63:41-48.

48. F. DeVito, B. Veytsman, P. Painter, **J. Kokini**. Simulation of the effect of hydrogen bonds of glucose and dextran using the Veytsman model. *Carbohydrate Polymers* 117:236-246.

49. P. G. Gezer, S. Brodsky, A. Hsiao, G.L. Liu, **J. Kokini.** Modification of the hydrophilic/hydrophobic characteristic of zein film surfaces by contact with oxygen plasma treated PDMS and oleic acid content. *Colloids and Surfaces B: Biointerfaces* 135:433-440.

50. P. G. Gezer, A. Hsiao, **J. Kokini,** G. L. Liu. Development of a biodegradable sensor platform from gold coated zein nanophotonic films to detect peanut allergen Ara h1 using surface enhanced Raman spectroscopy. *Talanta* 150:224-232.

Mauer

51. **B. Christina**, L.S. Taylor, **L.J. Mauer.** Physical stability of L-ascorbic acid amorphous solid dispersions in different polymers: A study of polymer crystallization inhibitor properties. *Food Research International* 76:867-877.

52. L.A. Wegiel, L.I. Mosquera-Giraldo**, L.J. Mauer,** K. J. Edgar, L.S. Taylor. Phase behavior of resveratrol solid dispersions upon addition to aqueous media. *Pharmaceutical Research* 32:3324-3337.

53. **R.A.L. Jutkus, N. Li**, L.S. Taylor, **L.J. Mauer**. Effect of temperature and initial moisture content on the chemical stability and color change of various forms of vitamin C. *International Journal of Food Properties* 18:862-879.

54. **L.J. Mauer, M. Allan.** An overview of water-solid interaction. *Manufacturing Confectioner* 95:73-82.

Narsimhan

55. E. Ruckenstein, G.O. Berim, **G. Narsimhan.** A novel approach to the theory of homogeneous and heterogeneous nucleation. *Advances in Colloid and Interface Science* 215:13-27.

56. **Y. Lyu, X. Zhu, N. Xiang, G. Narsimhan.** Molecular dynamics study of pore formation by melittin in a 1,2-dioleoyl-sn-glycero-3-phosphocholine and 1,2 di(9Z-octadecenoyl)-sn-glycero-3-phospho-(1'-rac-glycerol) mixed lipid bilayer. *Industrial & Engineering Chemistry Research* 54:10275-10283.

57. **G. Narsimhan.** Characterization of interfacial rheology of protein-stabilized air-liquid interfaces. *Food Engineering Reviews* DOI 10.1007/s12393-015-9133-z.

58. **X. Ning, Y. Lyu, G. Narsimhan**. Characterization of fish oil in water emulsion produced by layer by layer deposition of soy β-conglycinin and high methoxyl pectin. *Food Hydrocolloids* 52:678-689.

59. **N.M. Eren, G. Narsimhan**, **O.H. Campanella.** Protein adsorption induced bridging flocculation: the dominant entropic pathway for nano-bio complexation. *Nanoscale*, 8:3326-3336.

60. **G. Narsimhan**. Drainage of particle stabilized foam film. Colloids and surfaces *A: Physicochemical and Engineering Aspects* 495:20-29.

See **Yao** paper (Chen et al.)

Reuhs

See papers in **Ferruzzi** (Blount et al.), **Hamaker** (Lamothe et al; Rumpagaporn et al.)

Weil

61. **C.F. Weil**, M. Tuinstara, B. Dilkes, C. Addo-Quaye, J. Backlund, E. Danquah, H. Traore, **M. Massafaro,** M. McKneight, E. Azu, B. Babcock, A. Linville. Fully sequence indexed collections of chemically mutagenized plants: A tool for understanding gene function. *In Vitro Cellular & Developmental Biology- Animal* 51:S16-17.

Yao

62. L. Bi, L. Yang, A. Bhunia, **Y. Yao**. Emulsion stabilized with phytoglycogen octenyl succinate prolongs the antimicrobial efficacy of ε-poly-L-lysine against ESCHERICHIA coli O157:H7. *LWT Food Science & Technology* 70:245-251.

63. H. Chen, **G. Narsimhan**, **Y. Yao.** Particulate structure of phytoglycogen studied using β-amylolysis. *Carbohydrate Polymers* 132:582-588.

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

January

1. **Mario Ferruzzi.** Connecting food science research with nutrition outcomes: Why the food matrix matters in delivery of dietary bioactive polyphenols. Future of Food Lecture Series, North Carolina State University, Raleigh, NC.

March

2. **Srinivas Janaswamy.** Molecularly ordered biopolymers systems as novel host materials of bioactive compounds. International symposium on food carbohydrates, State Key Laboratory of Food Science and Technology, Jiangnan University, Wuxi, China.

3. **Juan Du, Owen Jones.** Block ionomer complexes formed by carboxymethyl-dextran-block-poly (ethylene glycol) copolymer and α-lactalbumin. American Chemical Society Spring Meeting, Denver, CO.

4. **Osvaldo Campanella.** Rheological considerations in food carbohydrates. International Symposium on Food Carbohydrates, Jiangnan University, Wuxi, China.

April

5. **Ozlem Duvarci, Gamze Yazar, Jozef Kokini**. Time dependency of structured food materials in large amplitude oscillatory shear. 10th Annual European Rheology Conference, Nantes, France.
6. **Mario Ferruzzi.** Playing nice at the interface of food science and nutrition: Exploring food matrix factors that impact delivery of phytochemicals. 12th Annual Russ Klein Nutrition Research Symposium, Columbus, OH.
7. **Mario Ferruzzi.** Leveraging the food matrix to deliver bioactive phytochemical metabolites to target tissues. NIH Office of Dietary Supplements Seminar Series, Bethesda, MA.
8. **Beth Pletsch, Bruce Hamaker.** Understand aspects of carbohydrate quality in rice related to difference in gastric emptying rate. Experimental Biology annual meeting, Boston, MA.
9. **Fatimata Cisse**, **Daniel Erickson**, A. Opeku, B. Nichols, **Bruce Hamaker.** Traditional foods made from sorghum and millet in Mali have slower gastric emptying than pasta, potatoes, and rice. Experimental Biology annual meeting, Boston, MA.
10. **Mohammad Chegeni, Bruce Hamaker**. Induction of differentiation of small intestinal enterocyte cells by maltooligosaccharides. Experimental Biology annual meeting, Boston, MA.
11. **Bruce Hamaker.** What is "carbohydrate quality" and can we use the concept to make healthier foods? Carbohydrate Competency Centre Annual Meeting, Groningen, Netherlands.
12. **Bruce Hamaker.** Thoughts on (semi)-predictable targeted modification of the gut microbiota using dietary fibers. Carbohydrate Competency Centre Annual Meeting, Groningen, Netherlands.
13. **Bruce Hamaker.** Modulating glycemic carbohydrates for health, starch structure and texture – some thoughts. Unilever R&D Centre, Rotterdam, Netherlands.
14. **Osvaldo Campanella.** Eighteen hour course on advanced rheology, Ceprobi, Instituto Polytecnico de Mexico.

May

15. **Jay Gilbert, Owen Jones.** Protein fibrils: improved stability and atomic force microscopy characterization. 2015 Joint Great Lakes/Central Regional ACS meeting, Grand Rapids, MI.
16. G. Gezer, L. Liu, **Jozef Kokini.** Surface enhanced raman spectroscopy sensor on a novel biodegradable platform. 4th International Conference on Bio-sensing Technology, Lisbon, Portugal.
17. **Bruce Hamaker**. Carbohydrate digestion and sustained energy. Jiangnan University, Wuxi, China.
18. **Osvaldo Campanella.** Methods to study rheological properties of foods and biomaterials and their role on processing. The 3rd Brazilian Congress of Rheology, Campinas, Brazil.

June

19. **Srinivas Janaswamy.** Molecularly ordered biopolymer systems: novel host materials of bioactive compounds. Biotechnology and Nuclear Agriculture Research Institute, Ghana Atomic Energy Commission, Ghana.
20. **Owen Jones.** Colloidal protein structures influenced by polyelectrolyte interaction for food or pharma application. University of Sao Paulo, Sao Paulo, Brazil.
21. **Jozef Kokini.** Advances in the non-linear rheological properties of foods, keynote speaker. 12th International Congress on Engineering and Food, Quebec City, Canada.
22. **Emma Barber,** G. Gezer, **Jozef Kokini.** Optimization of the manufacture of corn protein based nanophotonic films as sensors using surface enhanced raman spectroscopy to detect gluten allergen protein. 12th International Congress on Engineering and Food, Quebec City, Canada.

23. **Bruce Hamaker**, H. Xu, **Yunus Tuncil**, **Brad Reuhs**, E. Martens, L. Zhao. The 'discrete structures' of dietary fibers and potential to favor gut bacteria. International Scientific Association for Probiotics and Prebiotics (ISAPP) Conference, Washington, D.C.
24. **Osvaldo Campanella.** Using soft matter concepts in the study of foods. University of Sao Paulo, Pirassununga campus, Brazil.
25. **Osvaldo Campanella.** Research on food materials at Purdue University. University of Sao Paulo, Sao Paulo campus, Brazil.

July

26. **Matthew Allan, Lisa Mauer.** Water relations and intermolecular interactions in the recrystallization of single sugars and blends. Institute of Food Technology annual meeting, Chicago, IL.
27. **Seda Arioglu-Tuncil, Lisa Mauer.** The crystallization inhibitor properties of different polymers in thiamine hydrochloride amorphous solid dispersions. Institute of Food Technology annual meeting, Chicago, IL.
28. **Ning Xiang, Yuan Lyu,** X. Zhu, A. Bhunia, **Ganesan Narsimhan.** Antimicrobial peptide segments from soy protein for use in food safety. Institute of Food Technology annual meeting, Chicago, IL.
29. **Ning Xiang, Yuan Lyu, Osvaldo Campanella, Ganesan Narsimhan**. Pasting behavior of waxy maize starch. Institute of Food Technology annual meeting, Chicago, IL.
30. **Luis Maldonado, Ali Sadeghi, Menglu Gao,** A. Etorky, **Jozef Kokini**. Encapsulation and controlled release of curcumin with spherical and tubular nanoparticulated edible proteins. Delivery of Functionality in Complex Food Systems, Paris.
31. **Jozef Kokini.** A multidimensional approach to understanding oral processing and sensory attributes through biophysics, tribology and psychophysics. Institute of Food Technology annual meeting, Chicago, IL.
32. G. Gezer, **Jozef Kokini.** An atomic force microscopy study to understand zein and oleic acid self-assembly on nanoscale. Institute of Food Technology annual meeting, Chicago, IL.
33. **Menglu Gao, Luis Maldonado, Jozef Kokini.** Formation of lactalbumin nanoparticles by desolvation method. Institute of Food Technology annual meeting, Chicago, IL.
34. **Gamze Yazar, Ozlem Duvarci,** S. Tavman, **Jozef Kokini.** Investigating the rheological behavior of gluten fractions glutenin and gliadin in the non-linear region using LAOS. Institute of Food Technology annual meeting, Chicago, IL.
35. **Luis Maldonado, Jozef Kokini.** Effect of template nanopore-size on the formation of biocompatible nanotubes (BNTS) of BSA protein and alginate and carrageenan using layer-by-layer. Institute of Food Technology annual meeting, Chicago, IL.
36. **Mario Ferruzzi.** What is the role of "Food Science and Technology" in delivery of nutritious food? Institute of Food Technology annual meeting, Chicago, IL.
37. **Yunus Tuncil, Y. Xiao,** N. Porter, E. Martens, **Bruce Hamaker.** Dietary fibers as presented in a meal are utilized in a hierarchical order**.** Institute of Food Technology annual meeting, Chicago, IL.
38. **Beth Pletsch, Bruce Hamaker.** Brown rice delays gastric emptying to a greater extent than white rice independent of amylose content and starch digestion rate. Institute of Food Technology annual meeting, Chicago, IL.
39. **Tingting Chen,** L. Zhao**, Bruce Hamaker.** Dietary fiber generates gas and SCFA differently depending on original microbiota composition and fiber structure. Institute of Food Technology annual meeting, Chicago, IL.
40. **Fang, Fang, Osvaldo Campanella, Bruce Hamaker.** Shear-thickening behavior of waxy starch dispersions related to molecular characteristics. Institute of Food Technology annual meeting, Chicago, IL.

41. **Bruce Hamaker, Tingting Chen,** H. Xu, **Yunus Tuncil,** L. Zhao, E. Martens. Can dietary fiber structures be matched with targeted, predicted functions in the gut? Institute of Food Technology annual meeting, Chicago, IL.
42. **Osvaldo Campanella.** Methods to study rheological properties of foods and biomaterials and their role in processing. Shanghai Institute of Technology, Shanghai, China.
43. **Osvaldo Campanella.** Extrusion of food and non-food materials. Jiangnan University, Wuxi, China.

August

44. **Xi Wu**, P.-H. Wei, M. Wirth, A. Bhunia, X. Zhu, **Ganesan Narsimhan**. Investigation of effects of adsorption and immobilization onto silica nanoparticles on antimicrobial activity of Cecropin P1 and Cecropin P1C. American Chemical Society national meeting, Boston, MA.
45. **Yuan Lyu, Ning Xiang,** L. Zhou, X. Wu, **Xi Wu, Ganesan Narsimhan**. Pore formation in DOPC/DOPG bilayers by antimicrobial peptide melittin. American Chemical Society national meeting, Boston, MA.
46. **Ning Xiang, Yuan Lyv**, X. Zhu, A. Bhunia, **Ganesan Narsimhan**. Antimicrobial peptide segments from soy protein for use in food safety. American Chemical Society national meeting, Boston, MA.

September

47. **Bruce Hamaker.** Location of delivery of carbohydrate nutrients in the upper and lower gastrointestinal tract – its relevance to health. International Society for Nutraceuticals and Functional Foods 8th Annual Meeting, Wuxi, China.
48. **Owen Jones.** Macromolecular assemblies for delivery of nutraceuticals. International Society for Nutraceuticals and Functional Foods 8th Annual Meeting, Wuxi, China.
49. **Osvaldo Campanella.** Role of viscosity and rheological factors on food motility. International Society for Nutraceuticals and Functional Foods 8th Annual Meeting, Wuxi, China. Wuxi, China.
50. **Srinivas Janaswamy, Tianming Yao**. Ordered biopolymer systems as host materials of bioactive compounds. International Society for Nutraceuticals and Functional Foods 8th Annual Meeting, Wuxi, China
51. **Yunus Tuncil,** Y. Xiao, N. Porter, E. Martens**, Bruce Hamaker.** Dietary fibers as presented in a meal are utilized in a hierarchical order by human gut symbionts, and this order is carbohydrate structure dependent. Fall Symposium on the Microbiome, University of Michigan, Ann Arbor, MI.
52. **Bruce Hamaker.** How change in motility and locational delivery of glycemic carbohydrates in the GI tract may confer health benefit. Nestle Research Centre, Lausanne, Switzerland.
53. **Bruce Hamaker,** H. Xu, A. Kaur**, Brad Reuhs.** Discrete chemical and physical dietary fiber structures and their potential role in favoring gut bacteria. Probiotics, Prebiotics & New Foods, Rome, Italy.
54. **Bruce Hamaker,** H. Xu**, Yunus Tuncil, Brad Reuhs,** E. Martens, A. Keshavarzian, L. Zhao. Thoughts on developing dietary fibers for certain functions in the colon. Procter & Gamble Co., Cincinnati, OH.

October

55. **Jozef Kokini.** Nanotechnology in food science and agriculture – use of biodegradable platform made of zein for allergen detection. Symposium on Nanotechnology for Agriculture, Taipei, Taiwan.
56. **Jozef Kokini.** Advances in biodegradable sensor platforms. National Chung Hsing University, Taichung, Taiwan.
57. **Gamze Yazar, Ozlem Duvarci**, S. Tavman, **Jozef Kokini.** Non-linear rheological behavior of gluten free flour doughs and their correlation with bread properties. American Association of Cereal Chemists International annual meeting, Minneapolis, MN.
58. **Seda Arioglu-Tuncil, Lisa Mauer.** Impact of polymer physicochemical feature on the physical stability of citric acids amorphous solid dispersions. American Association of Cereal Chemists International annual meeting, Minneapolis, MN.

59. **Mario Ferruzzi.** Process for achieving dietary recommendations & current gaps in flavan-3-ol evidence. International Conference on Polyphenols and Health, Tours, France.

60. G.P. McCabe, **Mario Ferruzzi**, A. F. Brown, G.G. Yousef, C.M. Weaver, M.A. Lila. Application of phenolic profiling and principal component analysis to selection of blueberry germplasm for biomedical and nutritional research. International Conference on Polyphenols and Health, Tours, France.

61. **Sydney Moser**, J. Lim, J.D. Wightman, **Bruce Hamaker**, **Mario Ferruzzi.** Modulation of intestinal glucose uptake by phenolics in Concord and Niagara grape juices in a coupled *in vitro* digestion/Caco-2 model system. International Conference on Polyphenols and Health, Tours, France.

62. **Yunus Tuncil,** E. Martens, **Bruce Hamaker.** Growth rate of a human gut symbiont on starch is source dependent. American Association of Cereal Chemists International annual meeting, Minneapolis, MN.

63. L. Lamothe, X. Zhang, **Tingting Chen, Bruce Hamaker.** Unusual fermentation property of low gas production found in microwave solubilized quinoa fiber. American Association of Cereal Chemists International annual meeting, Minneapolis, MN.

64. **Xin Nie, Brad Reuhs**, E. Martens, **Bruce Hamaker**. Seemingly subtle structural features in corn arabinoxylan fractions induce a lag phase shift of Bacteroides xylanisolvens XB1A. American Association of Cereal Chemists International annual meeting, Minneapolis, MN.

65. **Beth Pletsch, Bruce Hamaker**. Gastric emptying rate of brown rice may be controlled by factors other than slower physical degradation in the stomach. American Association of Cereal Chemists International annual meeting, Minneapolis, MN.

66. **Tingting Chen**, A. Keshavarzian, **Bruce Hamaker**. Robust butryogenic effect of a mixture of fibers in in vitro fermentation. American Association of Cereal Chemists International annual meeting, Minneapolis, MN.

67. **Fang, Fang, Osvaldo Campanella, Bruce Hamaker.** The short-term structure of gelatinized waxy starch dispersions. American Associate of Cereal Chemists International annual meeting, Minneapolis, MN.

68. **Bruce Hamaker.** Considerations for simulating human digestion in vitro. American Associate of Cereal Chemists International annual meeting, Minneapolis, MN.

69. A. H-M. Lin, **Bruce R. Hamaker**. Starch and its nutritional quality. Koushik Seetharaman Memorial Symposium. American Associate of Cereal Chemists International annual meeting, Minneapolis, MN.

November

70. **Srinivas Janaswamy.** Ordered biopolymer systems as carriers of bioactive compounds. College of Food Science, Southwest University, Beibei Chongquing, China.

71. **Ning Xiang, Yuan Lyu,** X. Zhu, **Ganesan Narsimhan**. Antimicrobial peptides from soy protein – characterization of antimicrobial activity in terms of molecular properties by molecular dynamics simulation, Food Hydrocolloid Symposium. Jiangnan University, Wuxi, China.

72. **C. Wen, J. Pang, T. Talashek, Srinivas Janaswamy**. Effect of divalent cations on the structure function relationships of diutan. Food Hydrocolloid Symposium, Jiangnan University, Wuxi, China.

73. **Jozef Kokini.** An introduction to linear and non-linear viscoelasticity. University of Helsinki, Helsinki, Finland.

74. **Emma Barber**, D. Devina, **Jozef Kokini.** The effect of plasticizer and crosslinking agent on the formation and properties of zein films. European Federation of Food Science and Technology, Athens, Greece.

75. **Ozlem Duvarci, Gamze Yazar, Jozef Kokini**. The comparison of LAOS behavior of structured food materials (suspension, emulsions, and elastic network). European Federation of Food Science and Technology, Athens, Greece.
76. G. Gezer, **Jozef Kokini.** Engineering surface hydrophobicity of zein films via self-assembly. American Institute of Chemical Engineers meeting, Salt Lake City, UT.
77. **Mario Ferruzzi.** What is the role of "Food Science and Technology" in delivery of nutritious food? Obesity Society Meeting, Los Angeles, CA.
78. **Bruce Hamaker**, L. Lamothe, A. Kaur, A. Keshavarzian. Importance of physical form of insoluble fermentable dietary fibers on the gut microbiome. 6th International Conference on Food Factors, Seoul, South Korea.
79. **Bruce Hamaker**. Dietary carbohydrates to elicit positive physiological response in the body. Seoul National University, Seoul, South Korea.
80. **Bruce Hamaker.** Carbohydrate digestion and sustainable energy. TNO-Whistler Center Joint Short Course, Zeist, Netherlands.
81. **Osvaldo Campanella.** Rheology properties of food biopolymers. TNO-Whistler Center Joint Short Course, Zeist, Netherlands.
82. **Owen Jones**. Physical properties of food materials. TNO-Whistler Center Joint Short Course, Zeist, Netherlands.
83. **Yuan Yao**. Carbohydrate structure and starch modification: chemical, physical and enzymatic. TNO-Whistler Center Joint Short Course, Zeist, Netherlands.

December

84. **Ryan Murphy, Owen Jones.** Control of thermal fabrication and size of β-lactoglobulin microgels and their potential applications. New York Academy of Sciences, Journey through Science Day, New York, NY.
85. **Jay Gilbert, Owen Jones.** Electrostatic stabilization of β-lactoglobulin fibrils at increased pH with cationic polymers. New York Academy of Sciences, Journey through Science Day, New York, NY.
86. **Bruce Hamaker**, H. Xu, A. Kaur, **Brad Reuhs**. Designer prebiotics – can it happen? Nutrition Science Conference, Purdue University, West Lafayette, IN.
87. **Osvaldo Campanella.** Using soft matter concepts and modeling: an approach to understand the behavior of foods. Jiangnan University, Wuxi, China.

C. GRADUATE DEGREES AWARDED

1. **Lohit Myneedu, M.S.**, *Effect of salts on the structure-function relationships of sodium kappa-carrageenan,* May.
2. **Necla Mine Eren, Ph.D.**, *Physical chemistry of colloidal-nanoparticle interactions*, July.
3. **Amber Furrer, M.S.,** *Impact of processing on potato phytochemicals*, August.
4. **Krystin Marrs, Ph.D.**, *Effects of co-formulation on the water-solid interactions and behaviors of crystalline and amorphous solids*, August.
5. **Ana Steen, M.S.,** *The effect of processing conditions on the formation and properties of a soft, food-based nanoparticle delivery system*, August.
6. **Moriah Massafaro, M.S.,** *Mapping and identification of increased protein digestibility in sorghum,* December.

D. RECOGNITIONS, AWARDS, AND HONORS

1. **Lisa Mauer** received the Purdue University Corps of Engagement Award.
2. **Matthew Allan** won 2nd place in the oral presentation competition of the Food Chemistry Division at the Institute of Food Technologists annual meeting.
3. **Beth Pletsch** received the Best Poster Award in the Nutrition Translation, Research Interest section at the Experimental Biology annual meeting.
4. **Ning Xiang** won first place the Agricultural and Biological Engineering symposium poster presentation.
5. **Seda Arioglu-Tuncil** was a finalist in the AACCI Carbohydrate Division poster competition.
6. **Jay Gilbert** received the Australian Endeavour Research Fellowship.
7. **Ryan Murphy** received the IFT Feeding Tomorrow Graduate Scholarship and was an IFT Global Student Innovation Challenge finalist.
8. **Gamze Yazar** received the Isydore Hlynka Best Student Paper Award from the AACCI Rheology Division.
9. **Fang Fang** received 3rd place in the IFT Carbohydrate Division poster competition.
10. **Ana Steen** received 1st place for Best Student Paper in the Engineering Division at the AACCI annual meeting.
11. **Xin Nie** received 1st Place for Best Student Paper in the Nutrition Division at the AACCI annual meeting.
12. **Yunus Tuncil** received 3rd Place for Best Student Paper in the Nutrition Division at the AACCI annual meeting.
13. **Jennifer Allen** won 2nd place for her research poster at Minorities in Agriculture, Natural Resources, and Related Sciences 30th Annual Career Fair & Training Conference.
14. **Sydney Moser** received a student research award from the Phenolics and Health Research Interest Group.
15. **Amber Furrer** placed 2nd in the Emerging Leaders in Nutrition poster session by the Dietary Bioactive Research Interest section at American Society for Nutritional annual meeting.
16. **Sydney Moser** placed 3nd in the Emerging Leaders in Nutrition poster session by the Dietary Bioactive Research Interest section at American Society for Nutritional annual meeting.

E. SPECIAL EVENTS

Whistler Center Short Course, September 29 - October 1, 2015

We were pleased to include four guest speakers in this year's Short Course:

Dr. Madhu. Kale, from the USDA-ARS Western Regional Research Center in Albany, CA taught "*Basic principles in rheology*" and "*Rheology of polysaccharides: Concepts and experimental techniques*"

Dr. John Keller, a Food Industry Consultant specializing in hydrocolloids, taught "*Hydrocolloids and functionality*"

Dr. Amy Lin, an associate professor at the Bi-State School of Food Science at the University of Idaho and Washington State University, taught *"Glycemic carbohydrates and slow digestion"*

Dr. Johnson McRorie, a clinical scientist at Proctor & Gamble, taught *"Gut physiology and the physical effects of fiber: Plastics to visco-elastics"*

As is our tradition, the course was designed to provide one day of carbohydrate fundamentalson followed by two days of advanced special topic sessions. Day 1 consisted of a general session while advanced topical areas were presented on days 2 and 3. Each participant could attend 3 advanced topic sessions of their choice.

Tuesday General Session

1. Introduction to structures and properties of polysaccharides, J. BeMiller
2. Polysaccharide architecture, S. Janaswamy
3. Starch granule structure and properties, J. BeMiller
4. Basic principles in rheology, M. Kale
5. Polyols, high intensity sweeteners, and non-chemical modifications of starch, Y. Yao
6. Chemical modification of polysaccharides, J. BeMiller
7. Carbohydrate nutrition and labelling, B. Hamaker

Wednesday and Thursday Breakout Sessions

Advances in chemical and physical modifications of starch Part I & II, J. BeMiller

Beverage emulsions and encapsulation, G. Narsimhan and S. Janaswamy

Rheology of polysaccharides: Concepts and experimental techniques, M. Kale

The broadening world of prebiotics, B. Hamaker

Glycemic carbohydrates and slow digestion, A. Lin

Hydrocolloids and functionality Part I & II, J. Keller

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

Polysaccharide architecture and functionality including starch, S. Janaswamy

Gut physiology and the physical effects of fiber: Plastics to visco-elastics, J. McRorie

Extrusion and industrial products, O. Campanella

Predictive modeling of multicomponent systems, G. Narsimhan

Physical property testing of carbohydrates part I: Liquids, O. Jones

Physical property testing of carbohydrates part II: Solids, L. Mauer

Effect of plant phytochemicals on glucose homeostasis, M. Ferruzzi and B. Hamaker

Solubility and phase stability of polysaccharide mixtures, O. Jones

"Modifying starches for nutritional and functional properties"

2015 Belfort Lecturer
Dr. Yong-Cheng Shi
Grain Science and Industry, Kansas State University

Dr. Yong-Cheng Shi is a professor in the Department of Grain Science and Industry at Kansas State University (KSU). He received his Ph.D. in Grain Science with an emphasis in starch chemistry from KSU. Prior to becoming a faculty at KSU in 2006, he worked for National Starch Food Innovation (Bridgewater, New Jersey) from 1994 to 2005. His research areas include structure and function of cereal carbohydrates, physical, chemical, and enzymatic modifications of starches and flours, and developing technologies and products for food, nutrition, emulsion, encapsulation, and pharmaceutical applications. He has 16 granted US patents, numerous corresponding patents throughout the world, and more than 50 publications pertaining to starch and cereal carbohydrates. He co-edited a book with Dr. C. C. Maningat on Resistant Starch: Sources, Application and Health Benefits. He was an Associate Editor of Cereal Chemistry from 2006 to 2013 and currently sits on the Advisory Board of Starch and Food Digestion journals.