

DAIRY RESEARCH INSTITUTE™
NATIONAL DAIRY FOODS RESEARCH CENTERS



RESEARCH AND APPLICATIONS RESOURCES

Dairy Research Centers
Applications Labs
Facilities and Equipment
Support and Education



DAIRY RESEARCH AND APPLICATION CENTERS SUPPORT INNOVATION

National Dairy Foods Research Centers, supported by The Dairy Research Institute™, provide industry with dairy product and ingredient research and technical resources. To maximize research and product development, the Institute leverages the expertise of the dairy research centers and works in partnership with major universities and government agencies to help industry innovate to address unmet consumer demand for dairy and dairy-based products.

All dairy research centers have a dairy pilot plant and other facilities for research on dairy products, ingredients, processing and packaging. The dairy applications and technology development labs assist in prototype and concept development, product and process troubleshooting, product and process scaleup, and sensory evaluation.

Dairy Technical Support Line: 800-248-8829

www.USDairy.com

ABOUT THE DAIRY RESEARCH INSTITUTE

The Dairy Research Institute™ is a 501(c)(3)* nonprofit organization affiliated with the Innovation Center for U.S. Dairy™. It was established in 2010 under the leadership of America's dairy farmers through Dairy Management Inc.™ (DMI), the nonprofit organization that manages the producer checkoff program. The Institute was created to strengthen the dairy industry's access to and investment in the technical research required to drive innovation and demand for dairy products and ingredients domestically and abroad. The Dairy Research Institute works with and through industry, academic, government and commercial partners to increase pre-competitive technical research in nutrition, products and sustainability on behalf of the Innovation Center and the National Dairy Council®.

*application pending



CALIFORNIA DAIRY FOODS RESEARCH CENTER

**California Dairy Foods Research Center
Dairy Products Technology Center (DPTC)
California Polytechnic State University–
San Luis Obispo, CA**

www.dptc.calpoly.edu

University of California-Davis

California Dairy Research Foundation

www.cdrf.org



CENTER DIRECTORS

**Phillip S. Tong, PH.D.
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San Luis Obispo
805-756-6101/6102**

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**Joseph A. O'Donnell, PH.D.
Executive Director, California Dairy
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odonnell@cdrf.org

OVERVIEW

The California Dairy Foods Research Center is a comprehensive effort to bring the full capabilities of the Dairy Products Technology Center (DPTC) at California Polytechnic State University at San Luis Obispo and programs at the University of California-Davis to support the dairy industry from farm to table. Working with the California Dairy Research Foundation (CDRF), whose purpose is to promote research and development activities that benefit dairy producers and processors in the consumer marketplace, the scientists, technologists and other experts at the two universities continue to work with industry to provide innovative solutions that support the nation's dairy industry and the global marketplace. The California Dairy Foods Research Center conducts applied and strategic research and development in the areas of product technology and utilization, ingredient technology and utilization, products for health enhancement, food quality and food safety. Its applications and outreach programs facilitates innovative uses of dairy foods and ingredients by the food industry. Facilities at DPTC are state of the art, equipped with advanced and routine analytical equipment, pilot plants and a commercially licensed dairy processing facility. Adjacent to the DPTC is the university dairy farm where fresh milk is available for research and development activities.

CDRF supports the Foods for Health Institute (FFHI) at the University of California-Davis, which explores the concept that the components of milk represent the product of evolutionary pressure to deliver complete nutrition and health in the most efficient and effective way possible to growing mammals. Research from many campus laboratories across the College of Agriculture and Environmental Sciences, School of Medicine, School of Veterinary Medicine, College of Liberal Arts and Sciences and many institutes focuses on describing the health benefits of specific high-value milk components for commercial application. Commercial application will be facilitated by the Milk Processing Laboratory, which is part of the Robert Mondavi Institute of Wine and Food Sciences. The Milk Processing Laboratory within this facility will be searching for a director and installing equipment during 2011.

RESEARCH FOCUS

The California Dairy Foods Research Center offers significant expertise in and resources for research and development involving dairy products and ingredients. Research is industry-driven and can address the specific needs of companies in research or applications. Current research includes:

- Cheese technology (e.g., flavor, texture, yield, functional properties)
- Milk, dairy ingredients and dairy products quality (sensory, functionality, composition, physical properties) and shelf life
- Process development (e.g., membrane processes, UHT and other heat treatments, and nonthermal process evaluation)
- Product development, dairy ingredients applications (prototypes, nutritional labels) and flavor lexicons
- Dairy nutrition and health (e.g., probiotics, bioactives, milk genomics)
- Dairy quality assurance (e.g., food safety, environmental stewardship, testing methods development)

DAIRY INGREDIENTS APPLICATION PROGRAM

(Cal Poly State University, San Luis Obispo, CA)



This program provides technical support to manufacturers, users and marketers of dairy protein, dairy carbohydrate, and dairy fat-based powders and concentrates [nonfat dry milk (NFDM), skim milk powder (SMP), milk protein concentrate (MPC), whey protein concentrate (WPC), lactose, delactosed permeate (DLP), butter and milkfat]. It involves transfer of existing research information, preparation of information bulletins, providing solutions/information on technical product applications issues and conducting targeted short-term projects to address specific applications needs. Approximately 8,000 square feet of processing area is available in the pilot plant facilities. Applications support and specialized analytical capabilities are also available. A sensory program is available for consumer and trained panels. The plant is fully equipped for all traditional unit operations for the manufacture of dairy foods and ingredients and is licensed by the state of California for commercial manufacture of dairy foods. Additionally, space is available to accommodate specialized equipment for research and development projects on a short-term basis. Four analytical labs support work in areas of microbial, physical and chemical analyses of dairy foods and ingredients.

For additional information, visit
www.dptc.calpoly.edu/facilities.html

FACILITIES AND EQUIPMENT

DAIRY PRODUCTS TECHNOLOGY CENTER

California Polytechnic State University, San Luis Obispo

CONTACT: **PHILLIP S. TONG, PH.D.**
Director

805-756-6101/6102

ptong@calpoly.edu

FACILITIES AND EQUIPMENT

- EQUIPMENT:**
- HTST—270 to 600 gph for ice cream mix, milk, etc., and associated cold milk separator, batch tanks, pasteurized surge tanks, CIP systems, etc. (HTST is a legally sealed unit by the state of California)
 - Scholle filler for 3- to 6-gallon bags
 - Microthermics UHT (direct and indirect heating) with clean-fill hood and aseptic homo (25 l./hr.)
 - Continuous ice cream freezer (Hoyer Frigus SF 600) (50 to 150 gal./hr.)
 - Ingredient feeder (Hoyer Addus FF 2000 C2) (10 to 200 l./hr.)
 - Sawvel cup filler—pint to 3.5 oz.; 35 cups/minute (pint)
 - Emery Thompson batch ice cream freezer (40 qt.)
 - Egli continuous pilot-scale butter churn (1 to 2 lbs./min.)
 - PMS 30-gal./hr. HTST with two-stage homogenizer
 - Technogel 100-l./hr. continuous ice cream freezer
 - Marriott Walker rising film evaporator (100 lbs./hr. evaporative capacity)
 - Open-water jacketed cheese vats (Stoelting 500 gal., Stoelting 3 to 50 gal., Kusel 2 to 100 gal. with drain table)
 - 2 Universal 50-gal. specialty cheese vats
 - 150-gal. Damrow Double-O enclosed cheese vat
 - Blentech process cheese cooker (50 to 100 lbs.)
 - Stefan process cheese cooker (5 lbs.)
 - Suprema pasta filata system (mixer/molder and cooker/stretcher)
 - Koch vacuum packaging system (1- to 40-lb. block)
 - Miscellaneous tanks and pumps
 - High-shear Silverson mixer
 - 4 Groen process steam kettles (40 to 60 gal.)
 - 2 APV conical bottom swept-surface processors (100 gal.)
 - Legal batch pasteurizer system (200 gal.)
 - 4-booth sensory evaluation area with test/preparation kitchen
 - Controlled atmosphere cold storage (approx. 3,000 sq. ft.)
 - Cold storage (-15 to -40°F) (approx. 200 sq. ft.)
 - Spiral-wound DDS UF and RO system (50 to 100 l./hr.)
 - Niro Pilot R-12 MF/UF/RO system (60 to 90 gal. feed/min.)
 - Niro Filterlab spray dryer FLG-60 (60-lb./hr. water evaporation rate, capable of drying milk, whey and agglomeration)
 - Small pilot-scale supercritical carbon dioxide fluid extraction system

SUPPORTING ANALYTICAL EQUIPMENT

Fast-performance liquid chromatograph	Separation analysis and isolation of proteins from milk, whey and dairy products
Capillary electrophoresis	Analysis of proteins, DNA and RNA
Pulsed field gel electrophoresis	DNA-based differentiation of probiotic lactic acid bacteria
Gel electrophoresis acrylamide	Analysis of proteins and peptides: native, denaturing, urea, gradient and two-dimensional
Preparative isoelectric focusing	Isolation and characterization of proteins
Gel densitometer	Individual protein concentration determination
PCR thermal cycler	DNA characterization, bacteria identification and determination, gene manipulation, etc.
ELISA plate reader	Multiple antibody and enzymatic assays for milk product component analysis or microbiological safety
Membrane transfer platform	Northern, southern and western blots of RNA, DNA, and protein analysis and identification
Dot blot instrument	Antibody and enzyme quantification and titration
Ultracentrifuge	Sedimentation of milk and cellular components
Contrast phase microscope	Microbiological analysis of spores
Digital imager	Quantification and recordkeeping of dairy product sample structure and composition
Pilot plant scale affinity chromatography column	Large scale-up of laboratory affinity chromatography procedures
Gas pycnometer, tap density, powder flowability	Characterization of bulk density, particle density and angle of repose

SUPPORTING ANALYTICAL EQUIPMENT

GC/MS	Flavor and other compound characterization and identification
High-pressure liquid chromatograph (HPLC)	Peptide analysis from cheese ripening
Laser diffraction particle size analyzer	Particle size and particle size distribution of dry dairy powders, emulsions and colloidal dispersions
TX.T2 analyzer	Texture profile analysis, firmness, etc.
Formagraph	Coagulation studies
Hunter colorimeter	Whiteness, color intensity and hue, appearance of dairy foods and ingredients
Differential scanning calorimeter (DSC)	Thermal properties of milk components
Dynamic stress rheometer	Flow properties, gel strength, viscosity
Block digestion and distillation system	Nitrogen/protein analysis
Autotitration system	Determination of buffering capacity
High-throughput nitrogen analyzer	Quantification of total milk protein, casein and whey protein content of foods
Fourier transform infrared analysis	Milk component analysis

NOTE 1:

In addition to the specialized equipment available, DPTC routinely conducts chemical (fat, protein, ash, total solids, pH, etc.), physical (viscosity, color, etc.) and microbiological (APC, yeasts, molds, coliform, lactobacilli, etc.) analyses and related research, plus the development of dairy foods and ingredients.

NOTE 2:

In addition, Cal Poly works with several entities on campus (Materials Engineering, Biological Science and Food Science & Nutrition) for more specialized expertise, instrumentation, process equipment, etc.

Ongoing collaboration with the Cal Poly Environmental Biotechnology Institute (Dr. Raul Cano, director) provides access to the following capabilities:

- High-throughput DNA sequencing (gene or chromosome sequencing and species identification)
- Fatty acid methyl ester (FAME) analysis (used to determine strain relatedness of microorganisms of significance to dairy/food industry)
- Terminal restriction fragment polymorphism (TRFP) (characterization of changes in microbial communities)

UNIVERSITY OF CALIFORNIA-DAVIS

CONTACT: JAMES SEIBER, PH.D.
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The Department of Food Science and Technology has moved into the Robert Mondavi Institute. The new Food Science Teaching and Research Laboratory (including the Milk Processing Laboratory) will become fully operational in 2011.

FACILITIES AND EQUIPMENT

- EQUIPMENT:**
- Heat exchangers
 - Holding tubes
 - Evaporators
 - Jacketed stainless steel vats
 - Spray and freeze dryers
 - Swept-surface heat exchangers
 - Homogenizers
 - HTST
 - Ice cream freezers
 - UHT capability
 - Canning and blanching equipment
 - Walk-in cold rooms and freezers
 - Chest freezers (-120°F)
 - Magnetic resonance imaging equipment
 - Analytical equipment and lab capabilities
 - Packaging properties labs

COURSES, SYMPOSIA AND EVENTS

- Annual International Symposium on Milk Genomics & Human Health: www.cdrf.org
- Annual Symposium on Advances in Dairy Product Technology — Dairy Ingredients Symposium: www.dptc.calpoly.edu
- Annual Cheese Short Course: www.dptc.calpoly.edu
- Annual Dairy Processing 101 Short Course: www.dptc.calpoly.edu
- Annual Dairy Science and Technology Basics for the Farmstead/Artisan Cheesemaker: www.dptc.calpoly.edu
- Annual Frozen Dairy Desserts Manufacturing Short Course: www.dptc.calpoly.edu
- The International Milk Genomics Consortium (IMGC) provides a collaborative and interactive pre-competitive resource platform for researchers and research end-users to accelerate the understanding of the biological process underlying the mammalian milk genome: www.cdrf.org
- Dairy 101: www.dptc.calpoly.edu

RESEARCHERS AND STAFF

MATT ARNOLD

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Gas chromatography/mass spectrometry of cheese, cheese technology.

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Dairy ingredients applications support.

NANA Y. FARKYE, PH.D.

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Dairy chemistry and biochemistry, cheese technology, food enzymology, heat-induced changes in milk and milk protein structure-function relationships.

BRUCE GERMAN, PH.D.

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Functional deconstruction of milk oligosaccharides;
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Sensory evaluation of dairy foods and ingredients.

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Communications and outreach programming.

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Milk protein, function and quality of dairy products;
application of biotechnology to dairy; identification of dairy products' point of origin; characterization of milkfat globular membrane function in binding mechanism of probiotic bacteria.

RESEARCHERS AND STAFF

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Microbial and biochemical analysis of dairy foods.

JOHN KROCHTA, PH.D.

**Professor of Food Science & Technology,
Peter J. Shields Chair in Dairy Food Science, and Director
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Edible whey films and coatings; coatings for paper and plastic; polymers from lactose.

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Improving the fatty acid composition of milkfat;
identification of the high-growth gene in mice.

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Genomics of lactic acid bacteria; wine microbial ecology.

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MARY ELLEN SANDERS, PH.D.

Research Professor
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 California Polytechnic State University
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Probiotic microbiology; strain development of lactic acid bacteria; genetic improvement of starter cultures; in vitro characterization and identification of probiotic lactobacilli and bifidobacteria for commercial applications; speciation of lactobacilli and bifidobacteria; evaluation of probiotics on fecal microecology.

VANDNA SIKAND, PH.D.

Research Scientist
 Dairy Products Technology Center
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Functional properties of dairy ingredients.

PHILLIP S. TONG, PH.D.

Professor of Dairy Science
 Director, Dairy Products Technology Center
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Bioseparation of dairy food systems and processes; structure and stability of frozen desserts; physicochemical properties of dairy ingredients and food systems.

SEAN VINK

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Pilot plant operations.

ANGELA ZIVKOVIC, PH.D.

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MIDWEST DAIRY FOODS RESEARCH CENTER

University of Minnesota (St. Paul)
www.midwestdairy.umn.edu

South Dakota State University (Brookings)

Iowa State University (Ames)



CENTER DIRECTOR

Lloyd Metzger, PH.D.
Center Director
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OVERVIEW

The Midwest Dairy Foods Research Center has resources within the University of Minnesota (St. Paul), South Dakota State University (Brookings) and Iowa State University (Ames). The dairy center was formed to conduct research and provide support needed to increase the viability of the U.S. dairy industry and ensure its future competitiveness. The center offers expertise in dairy foods research for both traditional dairy products and dairy products used as an ingredient.

RESEARCH FOCUS

- Improving and controlling flavor development and functionality in cheese
- Improving the performance of cheese starter cultures through genetics
- Adding value to milk-based products with probiotics and nutraceuticals
- Improving shelf life of flavored milks
- Reducing undesirable taste attributes of milk
- Improving functionality and controlling flavor attributes of milk fractionation components
- Developing methods for effective and profitable uses of whey

FACILITIES AND EQUIPMENT

UNIVERSITY OF MINNESOTA

CONTACT: RAY MILLER
Plant Manager
612-624-7776
rmiller@umn.edu

FACILITIES

- Sensory Center
- Joseph J. Warthesen Food Processing Center
- Brining and sporulation room

FACILITIES AND EQUIPMENT

- EQUIPMENT:**
- Agglomerator: Glatt 3-lb. cap.
 - Blue cheese needler
 - Buhler extruder
 - Butter churn: Vane, 300 lbs.
 - CEM microwave (rapid moisture oven)
 - Cheese presses: vertical and horizontal with various hoop styles
 - Cheese vat: Damrow 5,000 lbs.
 - Cheese vats: Kusel 2,000 lbs.
 - Cheese vats: Nu-Vat, 800 lbs. (2)
 - Tetra-Hoyer SF600 Continuous ice cream freezer: 120 gal./hr.
 - Coating drum: Spray Dynamics
 - Curdmill: Damrow
 - Decanter: Sharples 1 gal./min.
 - Desludging centrifuge: Westfalia, 3 to 5 L/min.
 - Drum dryer: Buffalovac 6-in. drums
 - Dryer: Coulter, 90 lbs./hr.
 - Dryer: Niro, 20 lbs./hr.
 - Evaporator: CE Rogers, 200 lbs./min.
 - Food chopper and cutter: Hobart 10 lbs.
 - Fruit/nut feeder
 - Hammermill: Fitzpatrick, 5-lb. hopper
 - Homogenizers: Gaulin 30 and 125 gal./hr.
 - HTST and homogenizer: APV 30 gal./hr.
 - Microthermics: 1 to 3 l./min.
 - Mix process unit (vat pasteurizer, homogenizer and plate cooler): 50 to 100 gal.
 - Pasteurizer: Cherry-Burrell 4,000 lbs./hr.
 - Process cheese cooker: Blentech 10 lbs.
 - Process cheese cooker: Damrow 40 lbs.
 - PTI RO/UF system multitube
 - Storage tank: Cherry-Burrell 200 gal.
 - Ribbon blender
 - Scherping cheddaring belt: 200 to 300 lbs./hr.
 - Scherping cheese system: 2,500-lb. cap.
 - Separator: Westfalia 2,000 lbs./hr.
 - UF system: DDS-20, Plate and Frame, 10-l.
 - UF system: Osmonics 5m2, spiral-wound
 - Univats: Cherry-Burrell, 50 gal.
 - Vacuum pan evaporator: Rogers, 100 lbs.
 - Water activity testing

FACILITIES AND EQUIPMENT

SOUTH DAKOTA STATE UNIVERSITY

CONTACT: HOWARD BONNEMAN
Dairy Plant Manager
612-688-5480
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FACILITIES

- Dairy Research and Training Facility
- Dairy Pilot Plant

FACILITIES AND EQUIPMENT

- EQUIPMENT:**
- Batch freezer: 40-qt. Emery Thompson
 - Butter churns: 15 to 450 lbs.
 - Centrifugal pumps
 - Cheddar mill
 - Cheese block cutter (pneumatic)
 - Cheese press (pneumatic)
 - Cheese sealer: Sipromac
 - Cheese shredder: Hobart
 - Cheese vat: 2,500 lb. HCV
 - Cheese vat: 2x Kusel Double-O, 500 lbs.
 - Cheese vat: 1,000 lbs. fully enclosed, double-O on load cells with pre-draw and final drain
 - Drain table for HCV and 100 lb. Double-O
 - Cold bowl cream separator: DeLaval 5,000 lbs./hr. and 7500 lb./hr. cold bowl
 - Crystallization tank: 3,000 lb.
 - Dryer: two-stage with vibrating fluid bed, custom built, Dahmes Equipment
 - Evaporator: two-stage, falling film, custom built, Dahmes Equipment
 - Evaporator: vacuum-thermal, Blaw-Knox
 - Filler: Bag-n-Box, Scholle
 - Fruit feeder
 - Homogenizer: Gaulin 5,000 lbs./hr., 4,000 PSI
 - Homogenizer: 7,500 lb./hr. at 3,500 psi
 - HTST systems: 5,000 lbs./hr. and 7500 lb./hr.
 - Ice cream freezer: APV K110 150 gal./hr.
 - Sawvel cup filler for 6 to 64 oz. container
 - Rotary bottle filler for 8 oz. through gallon
 - Likwifier: 100 gal.
 - Microfiltration system: 1.7m², ceramic membranes
 - Niro spray dryer: rotary atomizer
 - Platform scales: 75 lbs. and 400 lbs.
 - Positive pump for revel in ice cream
 - Process cheese cooker: single-screw, 30-lb. culinary steam generator
 - Process vats: 20, 50, 200, 300, 500 and 600 gal.; steam and cool
 - Raw milk storage: 2 x 8,500 gal. silos
 - Refrigerated and frozen storage facilities, includes -40°F blast freezer
 - Steam culture chest
 - Ultrafiltration pilot lab, spiral-wound with 3.8-in. elements
 - Ultrafiltration, 4-stage, spiral-wound with 6-in. elements
 - Nano/reverse osmosis filtration, pilot lab, spiral wound with 3.8-in. elements

NOTE: A majority of systems will be control wired through “wonder ware” touch screens. Systems will have recoverable, downloadable data of VFDs, flow rates, pressure and temperature sensors.

FACILITIES AND EQUIPMENT

IOWA STATE UNIVERSITY

CONTACT: HUI WANG
 Pilot Plant Manager
 515-294-3572
 huiwang@mail.adp.iastate.edu

FACILITIES

- Dry processing pilot plant
- Fermentation facility
- Food microbiology lab
- High hydrostatic pressure processing facility
- Nutrition and wellness research center
 - Fitness and metabolism unit
 - Meeting rooms
 - Sensory evaluation unit
- Process development lab
- Product development capabilities
- Technology transfer pilot plant and theater
- Test kitchen and sensory lab
- Wet processing pilot plant

FACILITIES AND EQUIPMENT

A fee for use may be associated with some of the listed equipment. Please contact Stephanie Clark or Hui Wang if you are interested in more information about equipment or services provided at Iowa State University.

- EQUIPMENT:**
- Acid digester: Labconco
 - Aroma scan
 - Autoclave
 - Brookfields HBYR1
 - CEM Microwave Ashing System 300
 - Centrifuge: Autocrit Ultra 3
 - Centrifuge: Beckman J2-21
 - Centrifuge: Beckman J2-2M/E, refrigerated
 - Centrifuge: Beckman J2-HC, high-speed
 - Centrifuge: Cepa Z41, continuous
 - Centrifuge: Clinical
 - Centrifuge: Damon/IEC, tabletop
 - Centrifuge: IEC, explosion-proof, low-speed
 - Centrifuge: International Model HN
 - Centrifuge: Sorvall RC3B Plus
 - Centrifuge: Swing Bucket, 4-L
 - Centrivap concentrator: Labconco
 - Cheese press
 - Cheese vats: jacketed stainless steel w/agitation
 - Cold and dry storage lockers
 - Compression and injection molding machines
 - Consistometer: Adams
 - Consistometer: Bostwick
 - Extrusion systems for grain processing
 - Fermentors: Benchtop, 1-, 2-, 5-, 10-L
 - Fermentors: sterilizable-in-place, 15-, 50-, 100-L
 - Filters
 - Filtration unit: Amicaon hollow-fiber
 - Food extrusion
 - Freeze drying
 - Freezer: Ultralow (-70°C)
 - Refrigerator/Freezer: explosion-proof, isotemp
 - Gamma counter

FACILITIES AND EQUIPMENT

- EQUIPMENT:**
- Gas chromatography: Varian
 - Gas chromatography-mass spectrometry: Agilent
 - Glue depositing
 - High-Performance Liquid Chromatograph
 - High-Temperature Short Time Pasteurizer (Microthermics)
 - Homogenizer: Brinkman
 - Hunter Labscan XE
 - Incubator shaker: New Brunswick Sci
 - Instron 1122
 - Kettle: electric-heated with agitation, 10 gal.
 - Kjeldahl: Labconco
 - Membrane filter system
 - Microplate reader
 - Microscopes
 - Milestone M/S Meba Micro Digest Units
 - Oven: Fisher Isotemp
 - Oven: Lindberg Blue M
 - PCR Cycler: Biorad
 - Penetrometers
 - Photochem (oxidation potential system)
 - Plastic film and sheet extruder
 - Rapid Visco Analyzer
 - Refractometer
 - Retorts
 - Rotary evaporator and vacuum pump
 - Screens and mixing tanks
 - SLM French Pressure Cell Press
 - Spectronics XL-1500 UV Crosslinker
 - Spectrophotometer: Beckman DU 640
 - Spectrophotometer: Genesys 20
 - Spectrophotometer: HP PDA 8452
 - Spectrophotometer: Spectronic 21D
 - Spinning disc colorimeters
 - Spiral filter/pump
 - Stomachers
 - Texture analyzer (TAXT2)
 - Toxic diet prep room and pelletor and mixer
 - Ultracentrifuge: Beckman L8M
 - UV illuminator: Fisher Biotech
 - Vacuum oven: food-grade
 - Viscometers: Digital Brookfield (YR-1; HDB, RV)
 - Rotary evaporator: food-grade
 - Water activity meter: AquaLab
 - Wet grinders
 - Wire cheese block cutter

COURSES, SYMPOSIA AND EVENTS

University of Minnesota

- Food Entrepreneur Seminar
- Microbiology and Engineering of Sterilization Process
- Milk Pasteurization and Ultrafiltration Workshops

RESEARCHERS AND STAFF

Researchers and nutritionists work within the dairy research program and are closely aligned with the University of Minnesota Food Science Department, the South Dakota State University Dairy Science Department, and the Iowa State University Food Science and Human Nutrition Department, addressing new product development and processes for dairy products and ingredients.

RESEARCHERS AND STAFF

SANJEEV ANAND, PH.D.

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Food Safety**

South Dakota State University

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Public health microbiology of milk and food products, predictive microbiology, quality systems implementation, biofilms, nutraceuticals and molecular methods in microbiology. Bioluminescent markers and signal molecules.

ROBERT BAER, PH.D.

Professor of Dairy Science

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Dairy products with beneficial fatty acids, emulsifiers in low-fat and nonfat ice cream, analysis of dairy products.

LANCE BAUMGARD, PH.D.

Associate Professor; Norman Jacobson

Endowed Professor, Animal Science

Iowa State University

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Environmental and nutritional physiology; post-absorptive carbohydrate and lipid metabolism; bioenergetics; dairy science and nutrition.

DONALD BEITZ, PH.D.

**Distinguished Professor in Agriculture and Professor of
Animal Science and Biochemistry**

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Lipid metabolism; cholesterol; nutritional and genetic control of animal food.

TERRY BOYLSTON, PH.D.

Associate Professor of Food Science and Human Nutrition

Iowa State University

tboylsto@iastate.edu

Lipid and flavor composition of foods; conjugated linoleic acid formation in dairy products.

BYRON BREHM-STECHER, PH.D.

**Assistant Professor of Food Science and
Human Nutrition**

Iowa State University

byron@iastate.edu

Food safety and biosecurity; rapid molecular detection of food-borne pathogens and spoilage organisms; flow cytometry; biomimetics; multicomponent antimicrobial systems.

STEPHANIE CLARK, PH.D.

**Associate Professor of Food Science and Human
Nutrition; Associate Director of the Midwest Dairy Foods
Research Center**

Iowa State University

milkmade@iastate.edu

Applies food microbiology and chemistry approaches to bridge the gap between dairy product sensory quality and human health.

SAARI CSALLANY, PH.D.

Professor of Food Science

University of Minnesota

ascsalla@umn.edu

Lipids, vitamin E, oxidative enzyme systems, edible fats and oil nutritional biochemistry, free radicals.

RESEARCHERS AND STAFF

FRANCISCO DIEZ-GONZALEZ, PH.D.

Associate Professor of Food Science
University of Minnesota

fdiez@umn.edu

Food safety microbiology, food-borne pathogens, preharvest control of pathogenic E. coli, bioterrorism.

CARRIE EARTHMAN, PH.D.

Assistant Professor of Nutrition
University of Minnesota

cearthma@umn.edu

Clinical nutrition, medical nutrition therapy, body cell mass, nutrition support and assessment for patients at risk for wasting and gastric bypass surgery.

ASHRAF HASSAN, PH.D.

Associate Professor of Dairy Science
South Dakota State University

ashraf.hassan@sdsstate.edu

Lactic acid bacteria, fermented milks, low-fat cheeses and exopolysaccharides.

BARAEM ISMAIL, PH.D.

Assistant Professor of Food Science
University of Minnesota

bismailm@umn.edu

Phytochemicals, protein and enzyme chemistry; improving the functionality and bioactivity of food constituents; soy isoflavones (chemical structure, protein association, extractability, stability and bioavailability).

STEPHANIE JUNG, PH.D.

Associate Professor of Food Science and Human Nutrition
Iowa State University

jung@iastate.edu

High-pressure treatment of foods; effects of processing on food components (proteins and enzymes); use of enzymes to modify protein characteristics (extractability and functional properties).

THEODORE LABUZA, PH.D.

Morse Alumni Distinguished Teaching Professor of Food Science
University of Minnesota

tplabuza@umn.edu

Water activity, food stability and safety, food law, shelf-life testing, glass transition phenomena, bioterrorism, contaminants in food, time-temperature integrator tags.

BUDDHI LAMSAL, PH.D.

Assistant Professor of Food Science and Human Nutrition
Iowa State University

lamsal@iastate.edu

Food processing and engineering; crops utilization and industrial value-addition through enzyme application, fermentations and bio-based products; engineering properties of food; structure-functional properties of proteins, polysaccharides and food rheology.

PEGGY LEHTOLA

Assistant Director of Midwest Dairy Foods Research Center

University of Minnesota

plehtola@umn.edu

Assistant to the director.

RUTH MACDONALD, PH.D.

Professor and Food Science and Human Nutrition Department Head

Iowa State University

ruthmacd@iastate.edu

Identifying factors in foods that reduce the incidence of progression of cancer.

LARRY MCKAY, PH.D.

Professor Emeritus of Food Science

University of Minnesota

lmckay@umn.edu

Microbiology, gene transfer systems, plasmids, bacteriophages of cheese starter cultures, microbiology of food fermentations.

RESEARCHERS AND STAFF

AUBREY MENDONCA, PH.D.

Associate Professor of Food Science and Human Nutrition
Iowa State University

amendon@iastate.edu

Rapid detection of human pathogens in dairy foods;
development and application of natural antimicrobials to
enhance the safety and quality of dairy foods.

LLOYD METZGER, PH.D.

Associate Professor and Alfred Chair in Dairy Education,
Director of Dairy Center
South Dakota State University

lloyd.metzger@sdstate.edu

Structure and functional roles of cheese components
and modification of manufacturing parameters; cheese
technology; dairy products processing.

VIKRAM MISTRY, PH.D.

Professor and Department Head of Dairy Science
South Dakota State University

vikram.mistry@sdstate.edu

Reduced-fat dairy products; membrane processing;
process cheese manufacture; salt whey in cheesemaking;
cheesemaking characteristics of milks from Holstein and
Brown Swiss cows.

**KASIVISWANATH
MUTHUKUMARAPPAN, PH.D.**

Professor of Agricultural and
Biosystems Engineering
South Dakota State University

muthukum@sdstate.edu

*Dairy rheology and microstructure; physical and functional
properties of dairy products.*

DANIEL O'SULLIVAN, PH.D.

Professor of Food Science
University of Minnesota

dosulliv@umn.edu

Bacteriophage resistance and bacteriocin production
in lactococci, genetic regulatory circuits, genetic
fingerprinting, probiotic cultures.

DEVIN PETERSON, PH.D.

Associate Professor of Food Science
University of Minnesota

dgp@umn.edu

Flavor generation, characterization of flavor compounds and
flavor delivery in foodstuff.

GARY REINECCIUS, PH.D.

Professor and Department Head of Food Science
University of Minnesota

greinecc@umn.edu

Flavor chemistry, off-flavors and flavor processing.

R. ROGER RUAN, PH.D.

Professor of Biosystems and Agricultural Engineering
University of Minnesota

ruanx001@umn.edu

Imaging and spectroscopy technology, shelf-life testing,
structure-function relationships of biological materials.

DAVID SCHINGOETHE, PH.D.

Distinguished Professor of Dairy Science
South Dakota State University

david.schingoethe@iastate.edu

Distillers grains, fiber-digesting enzymes in dairy rations,
bovine somatotropin (bST), rumen bypass proteins and
dietary fat in lactating cows.

RESEARCHERS AND STAFF

TONYA SCHOENFUSS, PH.D.

Assistant Professor of Food Science
University of Minnesota

tschoenf@umn.edu

How formula and manufacturing processes affect natural and process cheeses, fermented milks and other dairy ingredients.

LESTER A. WILSON, PH.D.

University Professor
Iowa State University

lawilson@iastate.edu

Food quality determination (instrumental and sensory methods: color, flavor, aroma, taste, texture, viscosity and pungency); influence of radiation on rennet activity (NASA); food safety and quality training; influence of processing and storage on food acceptance.

ZATA VICKERS, PH.D.

Professor of Food Science
University of Minnesota

zvickers@umn.edu

Food aromas and acceptability; sensory evaluation of food; improved sensory and flavor techniques for fermented dairy products.

TONG WANG, PH.D.

Professor of Food Science and Human Nutrition
Iowa State University

tongwang@iastate.edu

Lipid chemistry and analysis; value-added processing and utilization of soybeans and other oilseeds; vegetable oil refining.



SOUTHEAST DAIRY FOODS RESEARCH CENTER



North Carolina State University (Raleigh)
www.cals.ncsu.edu/food_science/sdfrc/sdfrc.html

Mississippi State University (Starkville)

**Sensory Applications Laboratory
(North Carolina State University)**
www.ncsu.edu/sensory

CENTER DIRECTOR

Todd Klaenhammer, PH.D.
Center Director
919-515-4197
klaenhammer@ncsu.edu

OVERVIEW

The Southeast Dairy Foods Research Center, with facilities and support at North Carolina State University (Raleigh) and Mississippi State University (Starkville), has been operating since 1988 and actively participates in national research planning and execution on behalf of the dairy industry and other entities. The center's researchers work nationally on cutting-edge information and technologies, educate future professionals for the dairy industries, and help food processors address applications challenges and develop new products and processes using dairy products and ingredients. The center also hosts a Food Rheology Laboratory and a Sensory Applications Laboratory, conducting analytical, qualitative and affective sensory tests and flavor chemistry analyses tailored to meet specific needs of the food industry.

RESEARCH FOCUS

- Milk protein and whey ingredient functionality
- Thermal and biological processing
- Extended shelf-life processing
- Sensory properties and flavor chemistry of cheese and dairy ingredients
- Dairy food safety
- Dairy starter cultures and probiotics

SENSORY APPLICATIONS LABORATORY

The Sensory Applications Laboratory at North Carolina State University specializes in dairy sensory and flavor chemistry analysis, including consumer testing (qualitative and quantitative), preference mapping, instrument flavor analysis techniques (gas chromatography mass spectrometry, gas chromatography olfactometry and HPLC) and descriptive analysis. The center maintains three trained descriptive panels. Ongoing flavor research is primarily focused on dairy products (including milk, cheese, milk powders, whey proteins and butter), dairy ingredients applications, and how flavor varies with processing and storage. A specific focus is development of defined sensory languages and the application of these languages to enhanced product understanding, links to volatile compounds (flavor chemistry) and enhanced consumer understanding.

FACILITIES AND EQUIPMENT

NORTH CAROLINA STATE UNIVERSITY

CONTACT: TODD KLAENHAMMER, PH.D.
 Director, Southeast Dairy Foods
 Research Center
 919-515-4197
 sdfrc@ncsu.edu

FACILITIES AND EQUIPMENT

- EQUIPMENT:**
- Cherry-Burrell EQ-3 ESL Gable-top filler
 - Shrink-wrap oven
 - LiquiBox Semi-automatic Bag-n-box filler
 - Cheese vat—300 gal. (automatic stir, jacketed)
 - HTST system (700/350 gal./hr.)
 - Kusel 4MX cheese vat—65 gal.
 - Feldmeier tubular ultrapasteurization booster
 - Manual cheese vat—50 gal. (jacketed)
 - DeLaval 590 cold milk separator
 - Cheddar mill
 - Multiple batch tanks
 - Cheese hoops and presses
 - Admix Rotosolver submersible mixer
 - Koch vacuum sealer
 - Tri-clover blender
 - VRC multicoil processor XXI
 - CEM SMART Trac fat/solids analysis system
 - Feldmeier tubular heat exchanger
 - APV Gaulin 2-stage homogenizer
 - 75-kw continuous microwave processor
 - Ice cream processing
 - Marlen piston pump Model 629
 - Tetra Hoyer Frigus 600 freezer
 - ASTEPO low-acid aseptic Bag-n-box filler
 - Tetra Hoyer FF 2000 ingredient feeder
 - Radio Frequency Co. Macrowave processor
 - Tetra Hoyer variegation system
 - Superspeed and ultracentrifuges
 - Sweetheart rotary 4-oz. cup filler
 - Gas chromatography/mass spectrometry (GC/MS)
 - Sawvel rotary pint cup filler

FACILITIES AND EQUIPMENT

- EQUIPMENT:**
- Gas chromatography olfactometry (GCO)
 - Benchtop micro- and ultrafiltration
 - Pilot scale ultrafiltration
 - High-pressure liquid chromatography (HPLC)
 - Microscopy: light, phase and fluorescent
 - Microbiological support laboratory
 - Autoclaves
 - Rheometers
 - Electrophoretic analyses: DNA and protein
 - DNA fingerprinting
 - Kitchen preparation room
 - Consumer testing booths with Compusense™
 - Descriptive panel room
 - Sensory panel room
 - Atomic absorption spectrophotometry
 - Visible, UV and fluorescent plate readers
 - Mammalian cell culture
 - Stock retort and can sealer
 - Anhydro pilot scale spray dryer
 - Buchi benchtop spray drier

FACILITIES AND EQUIPMENT

MISSISSIPPI STATE UNIVERSITY

CONTACT: WILLIAM BENJY MIKEL, PH.D.
 Professor and Head, Food Science,
 Nutrition and Health Promotion
 Director, Food Science Institute
 662-325-5508, 662-325-8728
wmikel@fshp.msstate.edu

EQUIPMENT

- EQUIPMENT:**
- Double-O cheese vat—65 gal. with stirrers
 - Square cheese vat—100 gal., hand-stirred
 - 2 cheese vats—750 gal. with stirrers
 - 4 vats—2- to 3-gal. capacity, hand-stirred
 - Cultured products vat—50 gal., heated and stirred
 - Continuous ice cream freezer—150 gal./hr.
 - Emery Thompson batch ice cream freezer—5 liters
 - Anderson HTST unit
 - Anderson, 2-stage homogenizer (30 gal./hr.)
 - Walts UHT unit-indirect steam-heated (40 gal./hr.)
 - Romicon ultrafiltration unit (1,700 lbs./hr.)
 - CO2 freezing tunnel—24 ft. long
 - APV spray dryer—7 kg./hr., 1-meter diameter
 - Dayton Electric steam-closing canning machine
 - Rooneys semiautomatic canning machine

FACILITIES AND EQUIPMENT

- EQUIPMENT:**
- Retort—approx. 120 1-lb. cans
 - Kemotech smoking room—4-by-5-ft. firebox
 - CEM microwave moisture analyzer
 - APV homogenizer—2 stages
 - Gas chromatographs (GC)
 - HPLC
 - Mass spectrometers (MS)
 - Spectrophotometers
 - Ultracentrifuge
 - Oven
 - Walk-in freezer
 - Cooler
 - Grape crusher
 - Juice processing
 - Freeze dryers
 - Deep-fat fryers

COURSES, SYMPOSIA AND EVENTS

- Sensory and Instrumental Analysis of Dairy Flavors Short Course
- FS 324 Milk and Dairy Products (Internet-based distance education course)
- FS 554 Lactation, Milk and Nutrition
- Annual Farmstead Cheese Manufacture Short Course

RESEARCHERS AND STAFF

JON ALLEN, PH.D.

Professor of Food, Bioprocessing and Nutrition Sciences

North Carolina State University

jon_allen@ncsu.edu

Mammary gland biology and lactation; milk composition, chemistry and functional properties; mineral and vitamin nutrition and metabolism; food allergy; epithelial transport; regulatory biology; nutrition education; diabetes and obesity; glycemic index.

CHRISTOPHER R. DAUBERT, PH.D.

Professor of Food, Bioprocessing and Nutrition Sciences

Director of Food Rheology Laboratory

North Carolina State University

chris_daubert@ncsu.edu

Process cheese structure and texture; functionality of dairy ingredients; protein interactions in gel formation; fracture and texture design of dairy products.

MARYANNE DRAKE, PH.D.

Professor, Food, Bioprocessing and Nutrition Sciences, and Director of DMI Sensory

Applications Laboratory and NCSU Sensory Services Center

North Carolina State University

mdrake@unity.ncsu.edu

Sensory perception and chemistry of dairy flavors; understanding consumer needs, including market drivers and segmentation.

E. ALLEN FOEGEDING, PH.D.

William Neal Reynolds Distinguished Professor

Department of Food, Bioprocessing and Nutrition Sciences

North Carolina State University

allen_foegeding@ncsu.edu

Controlling astringent flavor and stability in high-protein/high-acid drinks; determining molecular and microstructural origin of textural properties in protein gels.

RESEARCHERS AND STAFF

TODD KLAENHAMMER, PH.D.

**Dairy Center Director,
Distinguished University Professor and
William Neal Reynolds Distinguished Professor**
Department of Food, Bioprocessing and
Nutrition Sciences

North Carolina State University

klaenhammer@ncsu.edu

Microbiology of starter cultures and probiotics; controlling fermentations and understanding probiotic bacteria through genomics.

CAROL REILLY

Program Coordinator
Southeast Dairy Foods Research Center
Department of Food, Bioprocessing and
Nutrition Sciences

North Carolina State University

carol_reilly@ncsu.edu
SDFRC@ncsu.edu

JOSIP SIMUNOVIC, PH.D.

Research Associate Professor
Department of Food, Bioprocessing and Nutrition Sciences
North Carolina State University

josip_simunovic@ncsu.edu

Conventional and advanced aseptic processing, continuous-flow microwave thermal processing, monitoring and validation of thermal processes for high-acid and low-acid dairy, particulate/multiphase foods and biomaterials.

GARY CARTWRIGHT

Dairy Enterprise System Director
North Carolina State University

gary_cartwright@ncsu.edu

Dairy processing, aseptic processing and packaging, continuous-flow microwave processing.

RAMA NANNAPANENI, PH.D.

Assistant Research Professor
Department of Food Science, Nutrition and Health
Promotion

Mississippi State University

nannapaneni@FSNHP.msstate.edu

Microbiological safety of soft processed cheeses.

WES SCHILLING, PH.D.

**Associate Professor, Food Chemistry and Sensory
Analysis**

Department of Food Science, Nutrition and
Health Promotion

Mississippi State University

schilling@foodscience.msstate.edu

Sensory and flavor analysis of foods; consumer testing, descriptive analysis, gas chromatography, flavor and preference mapping.



WESTERN DAIRY CENTER

Utah State University (Logan)
www.usu.edu/westcent



CENTER DIRECTOR

Donald J. McMahon, PH.D.
Center Director
435-797-3644
donald.mcmahon@usu.edu

OVERVIEW

The Western Dairy Center's primary location is Utah State University in Logan, with additional resources available at other universities in the Intermountain West. The faculty has extensive expertise in dairy processing/production, microbiology, chemistry and sensory analysis. An integral part of the center is a newly established Dairy Technology Innovation Laboratory group of researchers dedicated to providing innovative solutions to challenges and opportunities facing today's dairy processing industry.

RESEARCH FOCUS

- Cheese flavor and functionality
- Fermented products, including cheese and yogurt
- Ultra-high-temperature and extended-shelf-life fluid milk beverages
- Milk protein chemistry, including coagulation, denaturation and separation
- Milk fractionation and use of membrane separation in dairy foods
- Anaerobic digestion of dairy processing waste
- Whey protein extrusion
- Application of genetics, genomics and metabolomics to lactic acid bacteria
- Whey and milk utilization

FACILITIES AND EQUIPMENT

The Gary Haight Richardson Dairy Products Laboratory at Utah State University is a complete dairy processing facility. It operates daily to produce the dairy products used on campus. It also is used extensively by the researchers at the Western Dairy Center, as well as by researchers from industry for research and product development. Facilities are available on a daily basis for research, product development, formulation, manufacture and scale-up of dairy products. The efficient operation and flexible scheduling ensure a short turnaround time for the customers' products.

TO ARRANGE USE OF THE PILOT PLANT FACILITY, CONTACT:

CONTACT: RANDALL BAGLEY
 Manager, Gary Haight Richardson
 Dairy Products Laboratory
 435-797-2108
 randall.bagley@usu.edu

TO ARRANGE RESEARCH TRIALS, CONTACT:

CONTACT: CARL BROTHERSEN, M.S.
 Associate Director, Dairy
 Technology Innovation Laboratory
 435-797-3466
 carl.brothersen@usu.edu

- EQUIPMENT:**
- Two Scherping horizontal cheese vats (1,500 lbs.)
 - Three open cheese vats (500 lbs.)
 - Homogenizer and pasteurizer
 - Tetra Pak Sterilab ultra-high-temperature processor (steam injection and indirect heating)
 - High-pressure high-temperature extruder
 - Process cheese cooker
 - Ice cream freezer, continuous and batch
 - Ultrafiltration, microfiltration, nanofiltration and reverse osmosis separation

COURSES, SYMPOSIA AND EVENTS

- Basic Cheesemaking Short Course for Industrial Cheesemakers (Utah State University)
- Advanced Cheesemaking Short Course for Artisan Cheesemakers (Utah State University)
- Industrial Cheesemaking Short Course (with University of Idaho Extension)
- Artisan Cheese Symposium (Utah State University)
- GMP Workshop (Utah State University)
- HACCP Workshop (Utah State University)
- Advanced Sanitation Workshop (Utah State University)
- Behavior-Based Food Safety (Utah State University)
- SPC Workshop (Utah State University)
- SQF Workshop (Utah State University)

RESEARCHERS AND STAFF

DAVID BRITT, PH.D.

Assistant Professor, Biological Engineering
Utah State University

dbritt@cc.usu.edu

Surface chemistry, interfacial water structure (hydration layers) and associated surface potential of membranes and biomaterials as related to protein absorption and biofilm formation; lactose-hydrogels for enhanced water retention in soil and crop yield.

JEFF BROADBENT, PH.D.

Professor, Dairy Microbiology
Utah State University

jeff.broadbent@usu.edu

Genomics of lactic acid bacteria, non-starter lactic acid bacteria in cheese; improvements in low-fat cheeses; functionality in high-moisture cheeses; effect of oxidation reduction potential on growth of lactic acid bacteria; use of adjunct cultures.

CARL BROTHERSEN, M.S.

Associate Director, Western Dairy Center
Associate Director, Dairy Technology Innovation Laboratory
Utah State University

carl.brothersen@usu.edu

Chemical diffusion of molecules in cheese matrix; oxidation-reduction potential in Cheddar cheese; value-added cheese.

DAREN CORNFORTH, PH.D.

Winder Professor, Meat Technology
Utah State University

daren.cornforth@usu.edu

Dried milk mineral as an antioxidant in processed meats; lipid oxidation in precooked meats by dairy calcium and phosphoproteins; dried whey mineral as an antioxidant.

CONLY HANSEN, PH.D.

Professor, Food Engineering
Utah State University

conly.hansen@usu.edu

Anaerobic digestion as a waste management tool for decreasing effluent load from farms and food processing facilities and generation of energy.

SILVANA MARTINI, PH.D.

Assistant Professor, Lipids, Sensory Evaluation
Utah State University

silvana.martini@usu.edu

Technologies for designing healthy, high-quality, fat-containing foods for today's consumer; fat crystallization and phase transition theory; encapsulation; relationships between physicochemical properties of fats and emulsions and sensory characteristics.

DONALD J. MCMAHON, PH.D.

Director, Western Dairy Center
Director, Dairy Technology Innovation Laboratory
Professor, Dairy Food Processing
Utah State University

donald.mcmahon@usu.edu

Structure and function of casein proteins, milk coagulation, cheese manufacture, low-fat cheese texture and flavor, mozzarella cheese functional properties; membrane fractionation and processing of milk and whey; ultra-high-temperature processing of milk.

WILLIAM R. MCMANUS, M.S.

Research Technician
Utah State University

bill.mcmanus@usu.edu

Microstructure of foods, electron microscopy, confocal laser microscopy, low-fat cheese.

RESEARCHERS AND STAFF

BRIAN NUMMER, PH.D.

Assistant Professor, Extension Food Safety Specialist
Utah State University

briann@usu.edu

Food safety manager education, retail-foodservice food safety, small food entrepreneur food safety, home food storage, HACCP short course.

CRAIG J. OBERG, PH.D.

Regents Professor, Microbiology
Weber State University

coberg@weber.edu

Cheese starter cultures, microbiology of lactic acid bacteria, probiotic cultures.

KIMBERLY RASMUSSEN

Dairy Technology Innovation Laboratory Staff Assistant
Utah State University

kimberly.rasmussen@usu.edu

J. ANTONIO TORRES, PH.D.

Associate Professor, Food Process Engineering
Oregon State University

j_antonio.torres@oregonstate.edu

Novel and conventional applications of high-pressure processing with emphasis on bacterial spore inactivation mechanisms, in-line/real-time optical polarization measurements in food systems.

MARIE WALSH, PH.D.

Associate Professor, Dairy Chemistry
Utah State University

marie.walsh@usu.edu

Whey proteins (formulation, extrusion and production) in snack foods and meat extenders; immobilized enzyme reactors.

ROBERT WARD, PH.D.

Assistant Professor, Bioactive Food Components
Utah State University

robert.ward@usu.edu

Lipid analysis and metabolism, plus novel bioactivities associated with the milkfat globular membrane.

BALASUBRAMANIAN GANESAN, PH.D.

Research Scientist
Dairy Technology Innovation Laboratory

Utah State University

g.basu@usu.edu

Genomics, metabolomics and informatics of lactic acid bacteria.

DAVID IRISH, B.S.

Dairy Processing Specialist
Dairy Technology Innovation Laboratory

Utah State University

david.irish@usu.edu

Cheesemaking, UHT processing, filtration and membrane processing.

MICHAEL QIAN, PH.D.

Associate Professor, Food Science
Oregon State University

michael.qian@oregonstate.edu

Flavor chemistry, food analysis and dairy chemistry. Characterization of aroma compounds, and chemical and biological generation in dairy, small fruits and wines. Instrumental analysis of food components.

WISCONSIN CENTER FOR DAIRY RESEARCH

University of Wisconsin-Madison
www.cdr.wisc.edu



CENTER DIRECTOR

Mark Johnson, PH.D.
Interim Director
608-262-0275
jumbo@cdr.wisc.edu

OVERVIEW

The Wisconsin Center for Dairy Research (CDR) is located within a licensed, operating dairy plant on the University of Wisconsin-Madison campus and is one of the premier dairy research centers in the United States. Building on Wisconsin's tradition as the "Dairy State," the center explores functional, flavor and physical properties of cheese/cheese products and other milk components used as ingredients and as finished products. CDR researches cheesemaking and dairy protein processing/separation procedures, use of dairy ingredients in foods, and technologies for product safety and quality. More than 30 researchers and scientists are involved in conducting basic and applied dairy research. The facilities (including a pilot plant) and equipment are extensive, allowing the center to not only create new products, uses and processes, but also to meet the unique needs of the food industry.

RESEARCH FOCUS

- Explore and understand the functional properties of cheese and cheese products
- Recovery and/or modification of dairy ingredients, especially dairy proteins, to enhance value in food and nonfood uses
- Dairy food safety and quality systems
- Assistance to dairy manufacturers with product marketing, risk management and pricing issues

CHEESE

The University of Wisconsin-Madison has a long and proud history of cheese research and outreach. The CDR extends the art and science of cheesemaking into the realm of specialty cheese innovation, as well as cheese as an ingredient. Its licensed cheesemakers/scientists provide industry with training programs, research facilities, cheesemaking protocols for specific end use, and leading-edge technologies for adjusting the texture, taste and/or functionality of cheese in food applications.

The CDR cheesemaking pilot plant is located within the University of Wisconsin-Madison Dairy Plant, an operational dairy. This setting allows for flexibility in all aspects of the cheesemaking process. The facility is designed for manufacture of any retail cheese variety (fresh, cream, cottage, hard, soft, semisoft, surface-ripened, molded and eyed), process cheese and cheese food, plus cold pack.

CDR cheese applications staff, through consultation, pilot plant trials, applications laboratory evaluation, and on-site trials and visits, works in a confidential manner with all aspects of the dairy industry. From dairy producers and manufacturers to ingredients suppliers and equipment manufacturers, applications staff works with the entire cheese distribution system, including foodservice, retail, wholesale, brokers, converters, warehouses, executive chefs and quick-service restaurants — wherever cheese is used in food application systems.

Through consultation, pilot plant trials, applications laboratory evaluation, and on-site trials and visits, staff members also provide direct technical support for the end use of natural, process and cold pack cheeses, as well as cheese in food applications.

DAIRY PROTEIN/INGREDIENTS

CDR has an extensive program focusing on dairy ingredients. Working on a confidential basis, the program strives to meet the needs of regional and national dairy ingredient processors and food manufacturers. These needs include process, product and applications support. The dairy ingredient program and applications lab offer technical support for whey, buttermilk, nonfat dry milk, permeate, whey protein concentrate (WPC), whey protein isolate (WPI), individual whey proteins, milk protein concentrates and isolates, milk protein fractions and native whey protein. Services include information, training, seminars, process development, process troubleshooting, ingredient functionality testing and prototype development. Application areas of expertise are beverages, baked products, confections, dairy products, energy bars and prepared foods.

ANALYTICAL SERVICES

Analytical services are offered to support projects carried out at the Wisconsin Center for Dairy Research. The analytical support group provides comprehensive chemical and microbiological testing services and follows EURACHEM-CITAC Guide CG-2 as QA guideline of nonroutine and R&D analysis of samples. Tests performed include crude protein, casein, true protein, milkfat, total solids and mineral content by reference methods. Enzymatic determination of lactose and galactose, protein profiles of milk and milk products by capillary electrophoresis, and cheese proteolysis are determined routinely. The CDR has capabilities to determine particle size analysis and fatty acid composition by gas chromatography and the oxidative stability of oils and fats. Rheological tests performed include texture profiles, cheese meltability and functional properties of milk products.

Microbiological dairy food safety and quality tests are routinely determined, including tests for coliforms, standard plate count, plus yeast and mold. Shelf life and microbial challenge studies also are performed.

SAFETY/QUALITY APPLICATIONS



Providing an active approach to safety and quality, the CDR staff performs audits of dairy facilities, solves problems for dairy plants and reviews dairy facilities' good manufacturing practice (GMP) programs. CDR staff works with facility personnel to improve their GMP program and establish or modify an HACCP program. Staff members also interpret government regulations related to specific dairy products and dairy facilities and provide technical expertise in HACCP implementation and compliance with the Committee for the Assurance of Wisconsin Dairy Product Safety requirements.

In addition, cheese and dairy ingredients produced at CDR are monitored for microbial safety by the CDR Dairy Food Safety and Quality Applications Program.

DAIRY MARKETING AND ECONOMICS

This program provides support for cheese and dairy ingredients through process economics and plant applications, benchmarking production characteristic profiles, identifying strategic management characteristics, performing plant cost/benefit analysis of HACCP adoption, developing alternative uses for dairy-based ingredients, and using software for standardization and cheese yield calculations. For more information on this program, visit our website at <http://future.aae.wisc.edu>.

SENSORY ANALYSIS

This area designs, conducts and summarizes sensory analysis of cheese and dairy ingredients to meet the customers' needs. Evaluations include flavor, body/texture and appearance profiles, as well as cheese functionality for shredding/slicing and cooking applications. Panels conducted range from trained to focus group, from descriptive to consumer.

FACILITIES AND EQUIPMENT

The CDR pilot plant facilities meet the needs of the dairy and food processing industry by offering access to smaller-scale equipment. The small-vat new product development capability in the cheese pilot plant helps evaluate new cheesemaking processes. The dairy ingredient pilot plant has the capability to perform milk and whey processing of all types to produce beverages, yogurt, ice cream, sauces, spreads, dips and salad dressings. In addition, the applications lab at CDR has equipment to test the functionality of cheese as an ingredient, including a full line of foodservice pizza ovens. CDR also can evaluate the functionality of dairy ingredients and formulate dairy ingredients into baked products and confections. The chemical and microbiological laboratories extend more than 5,000 square feet and offer some unique testing capabilities.

FACILITIES AND EQUIPMENT

WISCONSIN CENTER FOR DAIRY RESEARCH/UW-MADISON PILOT PLANT EQUIPMENT

CONTACT: THOMAS SZALKUCKI
Assistant Center Director
Wisconsin Center for Dairy Research
608-262-9020
tszal@cdr.wisc.edu

EQUIPMENT: Full cheesemaking manufacturing line located in a state-licensed, state-inspected, operating dairy manufacturing facility. Natural cheese manufacturing line includes multiple raw storage tanks, separator, homogenizer, HTST, and various membranes (RO, UF, MF) for full milk standardization based on any desired ratios or incorporation of any ingredient before pasteurization of cheese milk. Capabilities to manufacture any style and variety of cheeses.

- 30-gal. bulk starter preparation tank
- pH meters with computer hookup to continuously monitor pH reading in 4 vats or redox potential in 2 vats over the course of manufacture
- 4 Stoelting 600-lb. vats with variable speed agitators and ¼-in., 3/8-in. and ½-in. knives
- 1 Kusel 5,400-lb. cheese vat
- 2 Kusel 600-lb. Double-O cheese vats
- 4 small 5-gal. capacity mini-cheese vats with automatic agitation with continuous pH monitoring
- Supreme steel fabricating cooker/stretcher (mixer/molder) Model 640 mixing machine; includes ends for string cheese, 5-lb. loaves with capability for 20-lb. block
- Stoelting prepress with 4 separate pressing chambers (for pressing of eyed cheeses)
- EBR curd mill for cheddared slabs
- Miller horizontal cheese press with 2 air rams
- Kusel A-frame vertical cheese press
- DR Tech Carousel Cheese Vacuum Press for blocks and horns
- Stainless steel cheese forms (Wilson 10-, 20- and 40-lb. block, perforated Brick/Muenster hoops, 5-lb. round Muenster hoops)
- Plastic cheese forms of various sizes and shapes, including 10-lb. wheels (both Crellin and Fromagex), 5-lb. loaves, smaller sizes for 1-lb. Edam balls, Camembert, ricotta and panela baskets, etc.
- Stacked fiberglass circulating brine system
- Hot Pack Environmental Chamber Model 317532 for ripening mold and surface-ripened cheeses; off-site ripening also available upon request
- Warm room capabilities for eyed cheese storage
- Various cold storage capabilities with variety of temperature ranges for cheese ripening

EQUIPMENT: Full cream cheese manufacturing line. Cream cheese manufacturing line includes items listed below, as well as equipment listed under other categories. Processing lines include cheese vats, pumping line to collect whey and cream cheese, holding vessel, through packaging.

- Sharples Penwalt Model DS2 cream cheese separator
- APV Gaulin homogenizer Model M3, 2-stage minimum, 2 gal. of product
- Scherping Systems PT 30G 30-gal.-capacity swept-surface tank with heating/cooling capability

Cold pack and processed cheese manufacturing line. Cold pack and processed cheese manufacturing line includes items listed below, as well as equipment listed under other categories. Processing lines include mixing/cooking vessels, homogenization and blending. All direct steam comes from culinary steam source.

- Biro cheese grinder, Model 922, includes various plate sizes
- Stephan cold pack cheese blender, 10-lb. capacity
- Stephan high-speed cutter, Model UMC 5, 5-lb. capacity, direct and indirect steam with vacuum
- Pick Heater for jet cooking sauces
- Blendtech twin-screw process cheese cooker, Model CC 0025, 20-lb. capacity, direct and indirect steam with vacuum
- Gerstenberg Schröder scraped surface heat exchanger (SSHE), Model VP 90/50
- Stephan vertical cutter/mixer, Model 17 91, 50-lb. capacity, indirect steam only
- Gerstenberg Schröder emulsifying machine for water/oil emulsions
- Gerstenberg Schröder mixing and holding tanks

Other various equipment used in the processing, converting and packaging of cheese:

- Winning Designs stainless steel butter churn, 1-gal. capacity
- Lincoln Impinger oven, Model 1130, for baking of Juustoleipä
- Urschel cheese shredder, Model CC-D
- Multivac vacuum sealer with gas flush capabilities, Model C400
- Vemag V 500 robot cheese grinder and vacuum machine with guillotine cutoff
- Variety of portable holding tanks

***PLEASE NOTE:** Additional equipment may be obtained by the CDR on a project-specific basis.

**DAIRY
INGREDIENT
PROCESSING
EQUIPMENT**

- Three spiral-wound UF- or MF-compatible systems that contain multiple vessels
- One system using up to six 3.8-in.-dia. vessels holding two elements each
- One system using up to two 4.3-in.-dia. vessels holding two elements each
- One system using one or two 8.0-in.-dia. vessels holding one element each
- NF or RO operated with one 3.8-in.-dia. vessel, one or two elements long
- Ceramic microfiltration system (not UF)
- One single-stage spiral-wound membrane filter system (UF/MF)
- Ceramic membrane system (UF/MF)
- Pilot-scale plate evaporator capable of 200 to 400 lbs. water evaporation/hr.
- Pilot-scale spray dryer capable of 40 to 60 lbs. water evaporation/hr.
- Stephan mixer with 40-liter capability
- Homogenizer (two-stage)
- Two pilot-scale milkfat separators
- Small HTST/UHT pasteurizer
- Ion exchange chromatography system – 10L
- Tanks ranging from 5 to 100 gal.
- Gerstenberg Schröder scraped surface heat exchanger (SSHE)
- Gerstenberg Schröder emulsifying machine
- Swept-surface jacketed tank with heating and cooling (100 gal.)
- APV Gaulin homogenizer Model M3, 2-stage minimum, 2 gal. of product

**ADDITIONAL
PROCESSING
EQUIPMENT**

- Ice cream: Emery Thompson, Taylor and Coldelite batch
- Taylor soft serve
- Ice cream: Tetra Pak continuous

SUPPORTING ANALYTICAL EQUIPMENT

Moisture analyzers	Total solids, moisture
Forced air ovens	Total solids, moisture, total solids (nonfat)
pH/mV meters	pH
Balances (capable of reading to 1 mg)	Fat, nitrogen, lactose, galactose, lactates, protein composition, acid degree value, titratable acidity, whey (undenatured) protein number, coliforms, yeast and mold, starter organisms, Lactococcus starter, non-starter lactic acid bacteria, Lactobacillus (hetero), standard plate count, ash, mineral analysis, triglycerides
Immersion sonicators	Solutions, suspensions, degasification
Centrifuges (various sizes to 25,000 rpm)	Soluble nitrogen, milkfat separation

SUPPORTING ANALYTICAL EQUIPMENT

Centrifuge rotors (fixed angle and swing bucket)	Soluble nitrogen, milkfat separation
Microcentrifuges	Protein composition
Microwave mineralization oven	Mineral analysis
Viscometer	Viscosity
Electrophoresis tanks	Protein composition (10 to 250 kD), protein composition (casein variants)
Electrophoresis power supplies	Protein composition (10 to 250 kD)
Capillary electrophoresis	Protein composition (10 to 250 kD)
Block digesters (6 and 20 Place)	Nitrogen content
Automated nitrogen analyzer with autosampler	Nitrogen content
Furnaces	Ashing
Cryoscope	Freezing point depression
ALP analyzer	Alkaline phosphatase
Melt meter	Melt test
-80°C freezers	Sample preservation, starter culture storage
Low-temperature incubators	Various microbiological tests
Refrigerated circulating water baths	Sample preparation
Rotary evaporators (1 liter)	Solvent evaporation
Soxhlet extractors (100 ml)	Fat extractions
Sample homogenizers	Sample preparation
Particle size analyzer (20-2000 um) with autosampler	Particle size determination

SUPPORTING ANALYTICAL EQUIPMENT

Inductively coupled plasma-axial optical emission spectroscope with autosampler	Mineral analysis
Gas chromatograph-flame ionization detectors with autosampler	Fatty acid composition, triglycerides, fatty acid sn- triglyceride positional analysis
High-performance liquid chromatograph with autosampler	Phospholipids, carbohydrates
Evaporative light scattering detector	Phospholipids, carbohydrates, triglycerides
Drop point analyzer	Melt point
Walk-in coolers (4°C)	Sample preservation
Commercial deli-style slicers	Melt test
Vacuum sealers	Sample preservation
Oxidative stability instrument	Accelerated oxidative stability
Chloride analyzers	Salt determination
Shaker water bath	Lactose

COURSES, SYMPOSIA AND EVENTS

- Applied Dairy Chemistry Short Course
- Cleaning and Sanitation Workshop
- Cheese Grading and Evaluation Short Course (2 times per year)
- Cheese Technology Short Course (2 times per year)
- Cultured Dairy Products Short Course (Odd-numbered years)
- Dairy and Food Plant Wastewater Short Course
- Dairy HACCP Workshop
- Dairy Ingredients Utilization Short Course
- Ice Cream Makers Short Course
- Dairy Ingredient Manufacturing Short Course
- Master Cheesemaker Short Course (Focus on specific trends and technologies in the manufacture of various cheeses)
- Milk Pasteurization and Process Control School (2 times per year)
- Process Cheese Short Course
- World of Cheese — Pasture to Plate Short Course

COURSES, SYMPOSIA AND EVENTS

- Various courses related to sustainability
- Custom company training programs for industry
- CDR Industry Team Research Forum
- International Cheese Technology Exposition
- Wisconsin Cheese Industry Conference
- Wisconsin Dairy Products Association Dairy Symposium

COMMUNICATIONS AND OTHER RESOURCES

- *The Dairy Pipeline* technical newsletter (published quarterly)
- Technical reviews
 - Dried Dairy Ingredients
 - Dairy Proteins
 - Whey Processing — Bleaching
- Fact sheets
 - Cracker and Cheese Pairing Guide
 - Distribution of Milk Components Between Cheese & Whey
 - Membranes 101
 - Membrane Configurations
 - Quick Guide to Choosing the Best Type of Whey
 - Relative Milk Component Sizes in Comparison with Membrane Pore Size Ranges
 - Use of Membranes for Standardizing Milk for Cheese Production
 - Guide to Smoked Cheeses
 - Brining Cheese, A Comprehensive Guide



RESEARCHERS AND STAFF

ROBERT BRADLEY, JR., PH.D.

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Processing and utilization of dairy foods, analytical methods of analysis; food product development; ultrafiltration and reverse osmosis, frozen dessert technology, analytical methods of food analysis and dairy foods technology; stabilization and emulsification of food systems, environmental toxicants in food products; independent third-party 3A mandated equipment cleanliness evaluations.

KIMBERLEE (K.J.) BURRINGTON

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Wisconsin CDR

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Coordinates dairy ingredients program targeting industry needs in the areas of whey processing/component separation and utilization of these components in a variety of food and beverage products.

CAROL CHEN

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Designs, conducts and summarizes sensory analysis of cheese; evaluations include flavor, body/texture and appearance profiles, as well as cheese functionality for shredding/slicing and cooking applications; types of panels conducted range from focus group to descriptive to consumer.

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Enzyme chemistry and technology; food chemistry; protein chemistry and technology.

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Food and bioprocess engineering; mass transfer and bioseparation processes; membrane bioseparations; protein purification; drying of foods and microorganisms.

KATHY GLASS, PH.D.

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Process cheese safety; shelf-life studies with food-borne pathogens; evaluation of product safety for new formulations.

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Develops decision-making tools for the dairy industry in the areas of process economics, plant applications, price risk management and demand for dairy products.

RANI GOVINDASAMY-LUCEY, PH.D.

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Evaluation of texture and rheological properties of cheese; standardization approaches for cheesemaking, including cheese yield determination; design of cheese projects/trials; determination of the coagulation properties of cheese milk; membrane processing for cheesemaking; cream cheese properties; buttermilk as an ingredient; low-fat cheese.

RESEARCHERS AND STAFF

SUNDARAM GUNASEKARAN, PH.D.

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Determining physical properties and quality factors of food materials and design of sensors and instrumentation for quality evaluation of food materials nondestructively; rheological and transport properties, structure-function relationships; value-added food and nonfood processes of biomaterials.

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Food engineering/processing, separations, crystallization/particulate processes, structure-function relations.

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Coordinator of microbiological services.

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Analytical methods for food analysis; microbial quality and safety of foods; HACCP, food quality and food safety.

STEVEN INGHAM, PH.D.

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Food microbiology; evaluating efficacy of intervention strategies against pathogenic bacteria in foods and beverages; HACCP critical limit validation.

JOHN JAEGGI

Cheese Industry and Applications Coordinator

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Coordinates cheesemaking trials; serves as an industry information resource, provides technical support for specialty cheesemakers.

MARK JOHNSON, PH.D.

Interim Director

Senior Scientist

Wisconsin CDR

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Coordinates CDR's strategic and applied cheese research program; cheese technology; manufacturing procedures and effects on quality; technology and microbiology of reduced-fat cheeses; enhanced ripening of cheese using lactobacilli; and cheese defects.

SUSAN LARSON, PH.D.

Research Specialist

Wisconsin CDR

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Dairy ingredient applications and responsible for the InnovateWithDairy.com website and dairy technical support line.

JOHN LUCEY, PH.D.

Associate Professor, Food Science

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Dairy chemistry/technology; physicochemical properties of dairy products; cheese technology; rheological properties of dairy products; milk proteins; yogurt science and technology.

RESEARCHERS AND STAFF

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SARAH MINASIAN

Applications Lab Coordinator

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With a culinary background, supports research and development application projects for the CDR.

GINA MODE

Assistant Coordinator, Cheese Industry & Applications Program

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Coordinates cheesemaking trials involving a wide variety of natural and process cheeses; provides information and technical support for brokers, end users, ingredients suppliers, manufacturers and others in the industry.

MIKE MOLITOR

Pilot Plant Technical Support

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Coordinates the center's pilot plant use for filtration, evaporation and spray-drying projects; serves as department resource for equipment design and maintenance; supports processing of dairy products, including yield and mass balance.

KIRK PARKIN, PH.D.

Professor, Food Science

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Food chemistry and biochemistry, particularly enzymology and bioactive phytochemicals and nutraceuticals; identification, characterization and enrichment of health promoting, bioactive compounds in foods; characterization of enzymes in foods and as processing aides.

SCOTT RANKIN, PH.D.

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Characterization primarily of dairy food flavor with sensory and instrumental techniques; programs and short courses in support of the dairy foods processing industry.

JUAN ROMERO

Analytical Services Coordinator

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Coordinates analytical activities for the CDR, including comprehensive chemical, microbiological, sensory and rheological testing services.

PAMELA L. RUEGG, DVM, MPVM, DABVP (Dairy Practice)

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Milk quality specialist; on-farm implementation of best management practices to improve milk quality and safety; research interests focused on the application of epidemiologic techniques to critical issues related to milk quality and safety; influence of cow and farm hygiene on milk safety and quality.

KAREN SMITH, PH.D.

Dairy Processing Technologist

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Specializes in process development, scale-up and troubleshooting; conducts research in milk/whey separation, concentration and drying; develops materials for industry education.

MARIANNE SMUKOWSKI

Safety and Quality Coordinator

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Serves as technical adviser to the dairy industry for safety/quality programs, HACCP implementation and dairy facility audits; facilitates industry/regulatory interactions; and is technical coordinator for the Wisconsin Master Cheesemaker® Program.

RESEARCHERS AND STAFF

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Serves as a resource for cheese manufacturers and end users interested in expanding the use of cheese, particularly as an ingredient.

JAMES STEELE, PH.D.

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Dairy microbiology; genetics and physiology of lactic acid bacteria; cheese flavor; probiotics.

TOM SZALKUCKI

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Serves as assistant to the director with specific additional duties related to projects, contracts, reports, technical information and CDR physical facilities.

DEBRA WENDORF BOYKE

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Coordinates all internal and external communication activities of the center.

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Quality and environmental concerns of the dairy industry; sheep milk processing.

DANA WOLLE, PH.D.

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Supports applied and basic research and development projects in both the dairy ingredients and cheese utilization group.

