MIDWEST DAIRY FOODS RESEARCH CENTER

RESEARCH PROJECTS

FUNDED BY MIDWEST DAIRY

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ABOUT MDFRC

Checkoff Supporter:

The Midwest Dairy Foods Research Center (MDFRC) funds research projects that advance dairy technologies, ingredients, and products through an industry-driven collaborative approach to strengthen the global competitiveness of Midwest dairy farmers.

MDFRC focuses on two primary areas:

1. Consumer solutions
2. Industry solutions with sustainability, food safety, and quality as foundational pillars across all projects

Typically, the process of selecting research projects begins with facilitated discussions between MDFRC researchers and industry members to identify emerging technical challenges for our industry members. These research needs are then prioritized by industry partners to ensure that the funded projects address the most relevant needs of the dairy industry. Because the research agenda is shaped and recommended by the dairy industry, MDFRC-funded projects are well-positioned to support new product development and improve processing technologies for the dairy industry.

I invite you to learn more by visiting https://midwestdairy.umn.edu.

Sincerely,

Dr. Jayendra Amamcharla

Director, Midwest Dairy Foods Research Center
Associate Professor, University of Minnesota

UNIVERSITY OF MINNESOTA

ENGINEER LACTOCOCCUS LACTIS TO PRODUCE A PEPTIDE-BASED ANTIMYCOTIC FERMENTATE

PI: Dan O'Sullivan (June 2023 to June 2025)

The objective of this study was to develop a natural antimicrobial peptide (AMP) that would control mold spoilage on cheeses and other foods. The project used a previously developed *Lactococcus lactis* expression system that was designed to encode the AMP with *L. lactis* molecular signals and produce fermentates enriched with the potent, plant-based antimycotic peptide. An AMP was extracted from rice and successfully introduced into a *L. lactis* expression system; however, the engineered plasmid was unstable and did not grow, so no antimicrobials were produced. Seven additional AMP expression plasmids were constructed using the same system; however, none of these engineered strains demonstrated antimicrobial activity.

RAPID BACTERIOPHAGE-BASED DETECTION OF LISTERIA MONOCYTOGENES IN MILK AND ENVIRONMENTAL SAMPLES

PI: Steven Bowden (June 2023 to August 2025)

The objective of this study was to provide a cheap, rapid, specific, and sensitive phage-based assay to detect DNA in live Listeria spp. in both liquid dairy ingredients and dairy processing environments. The developed method relies on the bacteriophage A511's fast replication, in combination with the LAMP colorimetric assay, that consistently identified Listeria at initial concentrations as low as ~1.7 CFU/mL following a single 24 h enrichment. These findings support the potential of phage–LAMP platforms to complement traditional methods and enhance the speed and reliability of pathogen detection in the food industry.

NOVEL STRATEGIES TO CONTROL OXIDIZED FLAVOR IN POWDERS

PI: Fernanda Dias (Jan. 2024 to Dec. 2026)

The shelf-life of dry dairy ingredients has a limited shelf life due to flavor defects caused by fat oxidation and off-flavors. This study is currently testing an emerging technology called electrospray drying (ESD) to determine if it produces superior milk powders with enhanced quality and sensory attributes. The ESD technology combines gas-liquid atomization and electrostatic charge to spray dry powders at temperatures at 40C or less, which reduces the impact on heat-sensitive flavor compounds. Current results show that dairy powders treated with ESD retained their higher moisture content with minimal change in overall composition. Compared to untreated samples, ESD-treated powders were the least oxidized and had significantly lower levels of off-flavors, making them the highest-quality samples among the powders tested. This project will contribute to the advancement of milk and milk products quality and benefit the dairy industry.

PHYSICAL AND CHEMICAL INHIBITION OF COLOR FORMATION IN PERMEATE POWDERS

PI: Job Ubbink (June 2025 to June 2026)

The browning of permeate powders during transport and storage is a major factor that negatively impacts the quality of permeate powders. This study is currently investigating the browning mechanism of permeate powders, focusing on physical stability and chemical reactivity as influenced by composition, temperature, and water activity. Samples from industry partners will be analyzed in tandem with model systems. Processing and formulation methods to prevent or reduce the browning will be evaluated. The project will generate important outcomes to address the key challenges faced by the dairy industry in producing high-quality permeate powders.

FUNCTIONAL MODIFICATION OF HIGH PROTEIN INGREDIENTS FOR TARGETED APPLICATIONS

PI: Jayendra Amamcharla (Jan. 2024 to Dec. 2025)

In recent times, high protein and clean labels have been driving consumer trends. Cashing on this trend for the dairy industry, it is important for dairy scientists to tailor the functionality of dairy-based ingredients. For example, the viscosity of yogurt is a technological challenge when formulating fermented products. Generally, the viscosity and chalky mouthfeel increase with protein content. This could lead to lower consumer acceptability and challenges during processing. Whey proteins are denatured upon heating and consequently are aggregated as microparticulated whey proteins (Micro-WP) under certain conditions (heat, protein concentration, pH, ionic strength, and shear). The Micro-WP are extensively studied as fat replacers. Selectively, whey proteins in the MPC will be converted as Micro-WP and thereby reduce the casein-whey protein interactions, leading to reduced viscosity even at higher protein levels. This project will optimize whey protein aggregation conditions, develop and characterize modified milk protein concentrating whey protein aggregates, and use modified milk protein concentrates in high-protein dairy fermented beverages.

DEVELOP AND VALIDATE RAPID AND ALTERNATIVE METHODS FOR SCORCHED PARTICLES IN DAIRY POWDERS

PI: Jayendra Amamcharla (Jan. 2025 to Dec. 2026)

Milk powder, a key global food ingredient with applications across the food and beverage industry, is prone to scorched particle formation during thermal processing. These scorched particles result from Maillard reactions and caramelization, negatively affecting product quality. Current methods for detecting scorched particles, such as the ADPI standards, rely on subjective visual assessments and are labor-intensive, with logistical challenges in filter supply. This project aims to address these issues by developing alternative methods for particle detection. These methods will improve the speed, accuracy, and scalability of quality control in dairy powder production, contributing to more reliable detection and better management of scorched particle formation in the industry.

RECOVERING WHEY PROTEINS FROM WHEY PROTEIN PHOSPHOLIPID CONCENTRATE DURING MICROFILTRATION OF WHEY PROTEIN CONCENTRATE

PI: Jayendra Amamcharla (Oct. 2024 to Dec. 2025)

This project will identify strategies to recover more protein from the microfiltration/diafiltration process.

SOUTH DAKOTA STATE UNIVERSITY

COW WATER FOR POTABLE AND PROCESSING USE

PI: Prafulla Salunke (Jan. 2024 to June 2025)

The study aims to evaluate cow water from various sources and determine whether it can be used as potable or processing water. We expect to develop and report new ways of water usage, either for drinking, processing, reconstitution, etc., which will reduce groundwater usage and increase sustainability efforts. Furthermore, the analysis will give insight into the quality of water available from various sources, and future studies on mitigation strategies, such as filtration and water safety, can be designed. Preliminary results for potable water analysis show that evaporator water and nano-filtered water have different compositions.

PRODUCTION OF LOW-COST GOS FROM WHEY PERMEATE STREAMS

PI: Maneesha Mohan (Jan. 2024 to Aug. 2026)

Galactooligosaccharides (GOS) are prebiotics produced commercially from refined lactose that are associated with several health benefits. There is high demand for GOS, but owing to their high cost, they are mostly used in high-value products like infant formula and toddler milk, with limited applications in other food products. The goal of the project is to produce low-cost GOS utilizing different whey permeate streams (including mother liquor). There are many advantages to using this waste stream. (1) It eliminates the expensive lactose refining process, (2) it uses a blend of yeast and enzymes that reduces the cost of using enzymes alone, and (3) it reduces the residual lactose and glucose content, which improves the purity of the final product. If successful, the low-cost GOS will have widespread marketability and numerous food applications.

DEVELOPMENT OF BIOSENSORS FOR CALCIUM, SODIUM, AND POTASSIUM MEASUREMENT

PI: Mazhar Sher (Jan. 2025 to Dec. 2026)

This project is using a laser-induced graphene-based biosensor that can detect sodium, potassium, and calcium from milk samples. Minerals, especially calcium, affect functionality and vary with the product matrix and conditions. Currently, there is no quick method of measuring calcium, which affects the control of product quality in milk beverages and cheese. Developing biosensors for mineral measurement is required for better quality and functional control during product manufacture. The characteristic advantage of our biosensors approach is its cost-effectiveness (less than $1 per sensor) and ease of use. The proposed sensors will help in the rapid detection of these three analytes from the milk samples.

ENHANCING THE BIO-PRESERVATIVE/BIO-PROTECTIVE BEHAVIOR OF NSLAB USING SOLUBLE FIBERS AS A PREBIOTIC DURING CHEDDAR CHEESE RIPENING TO PREVENT SPOILAGE

PI: Sanjeev Anand (June 2023 to June 2025)

This study explored the use of soluble fiber (inulin) as a novel strategy to selectively enhance NSLAB activity and control spore-related spoilage. Results show that adding soluble fiber in cheese manufacturing significantly enhanced NSLAB growth, stabilized microbial population, and suppressed spoilage by spores without compromising cheese quality. These results validate soluble fiber (inulin) as a clean-label, dual-purpose ingredient and support its application in industrial cheese production for improved microbial stability and controlling spoilage related to spores.

This study would help meet the demand of manufacturers looking for improved, shelf-stable cheese without defects. A novel range of fiber-rich cheese-line with improved microbiological physicochemical, nutritional, and sensory characteristics will be introduced in the market along with enhanced shelf-life targeting a large set of consumers around the globe.

IOWA STATE UNIVERSITY

COMBINED USE OF COLD PLASMA AND ANTIMICROBIAL FERMENTATES TO MITIGATE MOLD STORAGE OF SHREDDED CHEESE: A HURDLE TECHNOLOGY APPROACH

PI: Aubrey Mendonca (June 2023 to Dec. 2025)

The purpose of this study is to determine if low doses of cold plasma and antimicrobial fermentate will completely inactivate mold spores on cheese. This project uses high voltage atmospheric cold plasma (HVACP) to inactivate *Penicillium commune* and *Aspergillus flavus* on artificially inoculated shredded cheddar and mozzarella cheese. Current results show that HVACP caused significant sub-lethal injury to mold spores on both cheeses and extended their shelf life for 28 days longer than the untreated cheeses. When the HVACP-treated cheeses were stored at 4◦C, mold was able to regrow on mozzarella after 25 days, but there was no visible mold on cheddar stored after 45 days. This study shows that HVACP (80 kV/12 min) treatment has good potential for significantly inactivating Penicillium commune and Aspergillus flavus and extending the microbial shelf life of those popular dairy products, delivering a safe, clean-label product to consumers with extended shelf life.

CONTROL OF FUNGAL GROWTH TO EXTEND SHELF LIFE OF CHEDDAR AND MOZZARELLA CHEESE: IMPACT OF PACKAGING FILM COATED WITH NATURAL ANTIFUNGAL COMPOUNDS

PI: Aubrey Mendonca (Jan. 2025 to Dec. 2026)

The overall goal of this proposed research project is to prevent mold spoilage and extend the shelf life of packaged block cheese for which the vacuum has been compromised due to defects in the package. Our proposed approach is to develop an antifungal active packaging film that will deliver natural antifungal compounds to the surface of vacuum-packaged cheddar and mozzarella block cheese. The antifungal compounds will consist of a bacterial fermentate and a dairy-based volatile fatty acid such as hexanoic (caproic), octanoic (caprylic), or decanoic (capric) acids. We hypothesize that the combined action of antifungal treatments on the cheese surface and in the air that enters the package will extend the shelf life of the cheese.

UNIVERSITY OF MISSOURI

TUNING THE TEXTURE AND STABILITY OF EMULSIONS BY DAIRY PROTEIN-BASED INGREDIENTS

PI: Jeab Vardhanabhuti (Jan. 2024 to Dec. 2026)

University of Missouri

Products such as dip and sauce contain both emulsifiers and stabilizers. Most of these products use gums and starches for texturizing and stabilizing purposes. The goal of this project is to develop dairy protein-based systems that replace emulsifiers and stabilizers in dip and sauce applications. By utilizing the traditional emulsification properties, Pickering stabilization, and heat-induced changes of dairy proteins, we will be able design stable emulsions with a wide range of pH, oil contents, and rheological properties. Knowledge gained from this study should provide manufacturers with key information to utilize whey protein-based ingredients in food emulsions such as dips and sauces. Increased use and value of dairy ingredients will benefit dairy farmers and the dairy industry.


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