
The demand for milk and dairy ingredients is growing globally. To capitalize on this opportunity, US dairy exporters must become a supplier of choice to end-users in international markets. Spore-levels are top of mind for end-users that will manufacture ultra-high temperature (UHT) and shelf stable beverages, foods and nutritional formulas, because the presence of spores limits end-users' ability to use ingredients in those applications. The ability to control spore levels is crucial for ingredient suppliers targeting high-value applications. The US Dairy Export Council (USDEC) and National Dairy Council (NDC) teamed up to lead an effort to enhance the U.S. dairy industry’s capabilities to consistently produce milk powders that meet international customer specifications. Our initiative has advanced knowledge of best practices and delivered solutions for spore-control on the farm, in the plant, and during cleaning. In addition, we have gained a better understanding of the impact of spore-testing methodologies. Our research efforts have been amplified by the support from other farmer-funded state and regional organizations and industry partners. The transfer of technical knowledge catalyzed by this initiative led to the adoption of new practices, upgrades to current facilities, and major capital investments to build new milk powder plants. All these efforts have increased the US dairy industry capacity to supply greater volumes of low-spore milk powder to the global market. This talk will focus on why low-spore dairy ingredients are important for export markets and the specific objectives related to the USDEC-NDC milk powder quality enhancement program. This talk will also summarize some of the key findings from various projects that were supported through this initiative.

Spores in milk powders—Practical solutions for improved detection and important insights for predictability of spoilage of reconstituted products. R. T. Eijlander1, R. van Hekezen1, A. Bienvenu2, V. Girard3, E. Hoornstra4, N. Johnson5, R. Meyer2, A. Wagendorp1, D. C. Walker2, and M. H. J. Wells-Bennik*1, 1NIZO, Ede, the Netherlands, 2US Dairy Export Council, Arlington, VA, 3BioMérieux, R&D Microbiology, La Balme-les-Grottes, France, 4FrieslandCampina, Laboratory & Quality Services, Leeuwarden, the Netherlands, 5Nestec Ltd., Nestlé Research, Konolfingen, Switzerland, 6Abbott Laboratories, Columbus, OH.

Various bacteria produce spores as a survival mechanism under adverse conditions. Bacterial spores that are present in foods and ingredients may survive heat processing conditions that are applied for preservation of the finished product. When spores are exposed to conditions that allow for spore germination and outgrowth, spoilage of such products can result in costly product losses, or, in the case of outgrowth of pathogens, consumption of such products may result in food borne illness. Food or food ingredient companies rely on practical and fast microbiological methods to determine the amount of spores that are present in their products for routine risk assessments. The current ISO method aimed at enumeration of especially heat resistant spore in dried milk (ISO/TS27265; 2009) is not routinely applied, as it requires heating at an impractical temperature of 106°C. The efficacy and reliability of alternative methods rely on the actual heat load applied, the ability of the cultivation medium to support growth of all surviving spore species, and on the interpretation of the analytical results. In a collaborative effort of NIZO, Nestlé, BioMérieux, FrieslandCampina, Abbott and USDEC, the options for a practical and reliable spore enumeration method were investigated. In addition, the outcomes of the analyses of spore concentrations in powders were evaluated in relation to spoilage of reconstituted UHT treated milk by highly heat resistant bacterial spores that survived the heat treatment. This applied method involves a heat treatment at 100°C and plating on TSA, which was found to best support the recovery of commonly encountered spore forming species in dairy products. The study provides tools to standardize practical spore tests and enables improved interpretation of spore count test results in relation to spoilage risks of UHT-treated products made from milk powder.

Interventions for reduction of spore-forming bacteria at the farm level. A. Bianchini*, University of Nebraska-Lincoln, Lincoln, NE.

Bacillus and Paenibacillus spp. are spore-forming bacteria with the ability to survive the pasteurization process due to their spore structure. These bacteria can produce different enzymes that negatively affect the quality of dairy products, reducing the shelf life of fluid milk and limiting the market for powdered milk. Therefore, the control of sporeformers is crucial to improve the quality of fluid products and to reach specific international powder markets thus benefiting the US dairy industry. In this presentation, I will present an overview of sporeformers associated with the supply chain (fluid, condensed milk, and dry powder) along with potential interventions that may be applied at the farm level to control these microorganisms. It has been previously reported that effective cleaning of teats, changes in bedding material, and CIP procedures could be potential interventions to decrease sporeformers in milk. Additionally, the type of sanitizers (i.e., iodine or chlorine based) used in the parlor could have an effect in this microbial population. These potential interventions have been the subject of research at the University of Nebraska–Lincoln (UNL), with some of the interventions showing to be successful in improving the quality of raw milk. This presentation will provide a brief overview of spore research done at UNL in the last 5 years, along with results obtained so far from interventions at farm level to reduce spore-forming bacteria in raw fluid milk.

Strategies for minimizing sporeformers and spores during milk powder processing. S. Anand*, Midwest Dairy Foods Research Center, Dairy and Food Science Department, South Dakota State University, Brookings, SD.

High counts of thermodynamic sporeformers and their endospores in milk powders offer a major challenge in their marketability and utilization in further processing and product development. These organisms reduce the shelf life of products and cause many spoilages. This presentation includes strategies that we researched in our lab to minimize sporeformers in skim milk powders. In a typical dairy processing plant, the first step starts at the raw milk reception and storage stage. Based on the spore former population dynamics, regression models and contour plots were developed, which helped us choose specific temperature and storage duration combinations that would keep the population more toward vegetative cells. Our other research indicated that having a shift toward vegetative cells would result in lower biofilms on plate
heat exchangers (PHE) during pasteurization. Such biofilms are a source of contamination of milk being pasteurized. Certain stainless steel modifications were also tested for reduced biofilm formation on PHEs, which demonstrated reduced biofilm formation even during extended pasteurization runs up to 17h. By combining the above 2 approaches, it was possible to keep the sporeformers and spores counts low in milk and eventually in powders. Another approach that was found to be effective was to apply cavitation, combined with pasteurization, as an alternative processing step during the manufacturing of skim milk powder. Hydrodynamic cavitation was more effective, compared with ultrasonication, in reducing the counts of thermoduric sporeformers and their endospores. Pilot-scale trials successfully demonstrated that a 2 stage cavitation, when combined with pasteurization and followed through evaporation and spray drying, resulted in producing skim milk powder with reduced counts of sporeformers and spores. Further, combining optimized raw milk holding conditions based on regression models with that of hydrodynamic cavitation, as in line process step before pasteurization, was most effective in producing much lower spore count skim milk powder.

Key Words: sporeformers, spore, skim milk powder

75  Recurrence frequency and required intervention cleaning in place (CIP) of persistent populations of thermophilic sporeformers in milk powder production. T. Erickson*, Ecolab, Eagan, MN.

There is strong evidence that in many dairy processing systems a persistent population of spoilage organisms, often thermophilic sporeformers, survives cleaning in place (CIP) and can lead to high spore counts during subsequent runs. Deep-cleaning intervention CIP programs have proven to provide a tool for controlling these populations. However, added cost and potential impact on gasket lifetime point toward a need to limit the frequency of Intervention CIP. The optimal frequency varies by application, product, and plant design but can be characterized through evaluation of quality, production and sanitation records. Once established and confirmed, these periodic intervention CIP cycles help to optimize overall quality and drive consistency in production. Intervention frequency vary from days to weeks in plants of varying age and design, including purpose-built, low-spore plants.