Dairy Foods Symposium: Maximizing Value of Milk Proteins: Manufacture, applications and market opportunities for milk protein concentrate

245 Market trends and opportunities for milk protein concentrates. V. Lagrange,* *US Dairy Export Council, Arlington, VA.*

The US market for milk protein concentrates (MPC42–70) is estimated at 80–85,000 mt, and is complemented by a milk protein isolate (>85% protein) market estimated at 15–20,000 mt. MPC and MPIs range in protein content from approximately 42% to over 90%. Over 60% of the low-protein MPC (MPC 40–59) are used worldwide in dairy products (other than processed cheese). In Europe, yogurt and dairy desserts are an application where MPC's functional properties–improved viscosity, mouthfeel, emulsification, water binding–a favorable nutritional profile and the marketing appeal of a "clean label" increases their appeal. In the United States use in soups and sauces has increased significantly. Processed cheese dominates applications, although in the United States, volume used in this segment has decreased from 60% in 2007 to less than 40% in 2011. Almost all MPC purchases for use in specialty nutrition (sports, medical and clinical nutrition, geriatric nutrition) are high-protein concentration (80 percent or greater) products. The world market for milk protein isolates is estimated at 40,000 mt. These ingredients are highly valued in lactose free formulations and, increasingly, in medical nutrition product where they offer a milk dairy flavor and a desirable blend of "slow" and "fast" proteins. Clinical trials are underway in several locations to measure their effectiveness in the treatment of sarcopenia, the loss of muscle associated with aging.

Key Words: milk protein, milk protein concentrate, milk protein isolate

246 Impact of processing and storage on milk protein concentrate functionality. J. A. Lucey,* *University of Wisconsin-Madison, Madison.*

Milk protein concentrate (MPC) powder is basically skim milk powder with a reduced lactose (higher protein) content. Ultrafiltration (UF) is used to remove some lactose before drying, and UF processing may be adjusted to give MPCs that span a wide range of protein concentrations, for example, 40–85% protein in dry matter. High protein (>70%) MPCs can be slow to dissolve during rehydration and poor rehydration properties negatively affect the use of MPC in many applications. Another serious concern is that high protein MPCs can also exhibit a decrease in solubility during storage especially at storage temperatures > 20°C. Reports have indicated that some commercial MPC samples were prone to a large decrease in solubility during storage while other samples maintained good solubility. Differences in the mineral composition have been suggested as a possible explanation for variations in solubility behavior. High protein MPC requires extensive diafiltration to reduce the lactose content but this procedure also reduces the concentration of soluble salts. We have explored the impact of washing on protein solubility where washing was done with lactose solutions to remove soluble salts but not change the protein content. At least in our low protein MPC experiments, multiple diafiltration steps did not result in a disruption of the casein micelles or poor solubility during powder storage (although there was a loss of insoluble calcium from micelles). There are commercial MPC products that have been depleted of calcium, which presumably alters the micelle structure and casein-casein interactions that can occur during powder storage. High inlet air temperatures during MPC processing have also been suggested to impair solubility. Possible reasons include greater protein denaturation or enhanced Maillard cross-linking of proteins with lactose. A greater understanding is needed of the processing factors that determine MPC solubility.

Key Words: milk protein concentrate, solubility, functionality

247 Advances in processing and development of new milk protein products. H. Singh,* *Riddet Institute, Massey University, Palmerston North, New Zealand.*

The global demand for milk protein has increased significantly in recent years due to better understanding of its nutritional value, physiological and bioactive properties, and newly developed functional uses. In particular, consumer awareness of the benefits of protein in sports performance, weight management, lean muscle mass retention, satiety and general wellbeing has improved considerably over the last decade. Consequently, the demand for milk protein-enriched food and beverage products has moved into the mainstream as they appear to deliver these benefits more readily than other food proteins. The dairy industry produces a vast range of milk protein products, specifically designed for particular applications. These products include the traditional milk protein products, such as skim milk powder and whey powders, and higher protein products, such as caseins and caseinates, whey protein concentrates and isolates and milk protein concentrates and isolates. Among the higher protein products, milk protein concentrates (MPCs) and whey protein isolates (WPIs) have become very important for the dairy industry, as they provide several processing and functional/nutritional advantages over traditional milk powders. MPCs are now commonly added to milk or cheese formulations to enhance the protein content and to improve texture of yogurts. The use of MPCs in nutritional products is growing. In this application, MPC provides both casein and whey proteins in the same ratio as in milk, but without the high lactose content. However, several functionality problems are associated with high protein MPCs, including cold water solubility. Various patented processes have been developed for manufacturing MPC powders with improved functional characteristics, involving alterations in mineral balances and/or the state of aggregation of whey proteins. Development of high protein foods poses several functionality challenges, such as self-association/aggregation and high viscosity of proteins. New types of protein products and associated processes are being developed to overcome some of these technical challenges.

Key Words: milk protein, processing, functionality

248 Manufacture and application of micellar casein concentrates. D. M. Barbano,* *Cornell University, Department of Food Science, Northeast Dairy Foods Research Center, Ithaca, NY.*

Micellar casein concentrate (MCC) is currently produced by removal of intact casein micelles from skim milk by microfiltration. The casein micelles may be further concentrated by ultrafiltration or evaporation. Liquid MCC may be used directly as a fresh ingredient, concentrated and stored as a long shelf-life refrigerated ingredient, or dried and stored for later use as a powdered ingredient. The MCC are different from caseinates, and acid and rennet caseins because the casein in MCC still retains its micelle structure and bound calcium. Casein in MCC is in the same form as casein in NDM powder and milk protein concentrates (MPC) produced by ultrafiltration. The difference between MCC and

NDM or MPC, is the presence of other dairy solids that will cause differences in functionality among these 3 products. The MCC can be produced in a range of purities. The key compounds being removed by microfiltration in the manufacture of MCC are milk serum proteins, lactose, soluble calcium phosphate, monovalent ions, and nonprotein nitrogen compounds. A technically feasible microfiltration process could continuously discharge a high-purity liquid MCC which has been 95% reduced in serum protein and soluble NPN compound contents at 9% true protein and < 0.2% lactose (both on wet bases). This liquid MCC could be further concentrated or dried. The liquid protein concentrate is bland in flavor, white, and viscous. Highly concentrated liquids have some unique properties. The MCC has excellent heat stability; when used as an ingredient in retorted beverage production, there is minimal browning and cooked flavor formation during sterilization. While MCC could be used as an ingredient in making nonstandardized cheeses in the US, the higher value uses for MCC may be as an ingredient in retorted, shelf-stable, high protein beverages and as an ingredient in low-fat natural cheese manufacture.

Key Words: micellar casein concentrate, microfiltration, serum protein removal

249 Performance of spiral wound microfiltration membranes during production of micellular casein concentrate. L. E. Metzger,* C. Marella, and P. Salunke, *Midwest Dairy Foods Research Center, South Dakota State University, Brookings.*

Micellar casein concentrate can be manufactured from skim milk by microfiltration that utilizes membranes with an average pore size of 0.1 - 0.2µm. The microfiltration process concentrates micellar casein by selectively permeating whey proteins, lactose, and soluble minerals. In contrast to other processes for isolating casein (isoelectric precipitation or rennet induced coagulation), microfiltration has the advantage of concentrating micellar casein in its native state. The most common types of membranes used to microfilter milk are ceramic or spiral wound. In general ceramic membranes have an advantage in terms of performance whereas spiral wound membranes have an advantage in terms of cost. The data related to microfiltration of milk using spiral wound membranes has been collected using small scale manufacturing systems and short processing runs. This is an issue for manufacturers that attempt to scale up and commercialize microfiltration since the performance characteristics of spiral would microfiltration membranes are influenced by a variety of operating conditions and the selectivity of the membrane can vary substantially during a production run. In this study the performance of a 4 stage microfiltration system during a 15–20 h production run at 2 serum protein removal levels (40% and 85%) was determined. Relative to small scale systems, the continuous, single pass 4 stage process resulted in improved whey protein removal over the processing run. However, data on flux rates and selective passage of the major whey proteins showed that even though flux rates remained fairly constant, the membrane selectivity varied during the process run. This flux rate and selectivity data can be utilized by manufacturers to design a spiral wound microfiltration process to achieve their desired whey protein removal targets.

Key Words: micellar casein concentrate, spiral wound, microfiltration