DAIRY FOODS SYMPOSIUM: ADVANCES IN DELIVERY OF DAIRY INGREDIENTS FOR HEALTH AND FUNCTIONAL BENEFITS

0233 Market opportunities for dairy proteins. A. Bienvenue*, *U.S. Dairy Export Council, Arlington, VA.*

The protein trend, popular among athletes for decades, has now reached several mainstream segments. Consumers – especially in the United States and Western Europe – have become increasingly aware of the benefits of protein in the diet for satiety, weight management and muscle-related benefits such as exercise recovery and healthy aging. Food manufacturers now offer beverages, bars, cereals, meals and yogurts formulated to deliver increased levels of protein, while maintaining a good taste profile. In Asia and the Middle East, the protein trend is at the cusp of what we are seeing in the United States and Europe. Growth in demand for protein-rich foods is expected as consumers in these regions achieve greater financial prosperity, become aware of health trends in other countries, and move toward a more Western diet. The demand for protein-rich foods presents a huge opportunity for dairy's many products and ingredients. Dairy protein can deliver good taste, functionality, fast and/or slowly digested proteins and superior nutrition in a product formulation. In order to capitalize on formulators' desire to increase protein levels in foods and beverages, dairy suppliers must offer ingredients that will meet buyers' specifications, consistently perform and deliver a high-quality finished product. Dairy ingredient performance depends on the protein type, structure, pH, ionic strength, interactions with other ingredients in the formula and processing conditions of the finished product. Therefore, it is crucial for suppliers to understand formulators' parameters to help in selecting the best dairy ingredient functionality for a food system. In a highly competitive marketplace, formulators have choices of ingredients to increase protein levels in food formulation. The Digestible Indispensable Amino Acid Score (DIAAS), the new FAO-recommended method, demonstrates the higher bioavailability of dairy proteins when compared to plant-based protein sources. Dairy proteins can therefore distinguish themselves by the excellence of the nutrition they deliver. To allow for more dairy protein to be used in a wide variety of food applications, the dairy industry must accelerate innovation to expand the offering of cost-effective ingredients that will perform consistently under diverse processing conditions and challenges. Examples of the attributes requested include: for beverages, improved heat stability across a wide pH range, greater clarity and a very clean flavor profile; in bar applications, a dairy protein that can resist hardening over time. Dairy protein ingredients that maintain flavor, color, solubility and flowability throughout their shelf life, even in hot and humid environments, are highly desired for export markets..

Key Words: dairy protein, functionality, export.

0234 Using charged membranes to improve dairy protein ingredients. M. Etzel*, *University of Wisconsin, Madison*.

This research examines two hypotheses: (1) negatively charged ultrafiltration (UF) membranes can be used to manufacture whey protein and milk protein ingredients at enhanced flux, and (2) positively charged UF membranes can be used to make dairy protein fractions without the use of chromatography. Charged UF membranes are fabricated from normal uncharged UF membranes. The membrane charge combines with the membrane molecular weight cutoff to control whether or not proteins permeate or are retained by the membrane. At the neutral pH of milk and whey, the major proteins are charged negative and are rejected by a negatively charged UF membrane, allowing the use of wide pore size membranes that operate at high flux. Compared to current uncharged 10 kDa membranes, 100 to 300 kDa charged UF membranes have a 2−5× higher flux at the same or increased protein retention. We scaled up this technology 1400× from 50-1000 cm^2 flat sheet systems to 70,000 cm2 spiral wound systems. In the fractionation of proteins from milk or whey, chromatographic purity can be obtained without the use of chromatography. For example, by attaching a positive charge to a 300 kDa UF membrane, selectivity increased by a factor of 3 for fractionating bovine α-lactalbumin from β-lactoglobulin in milk-serum, compared to an unmodified membrane. Thus, like-sized proteins that differed only somewhat in isoelectric point and size and that were about 15-20 times smaller than the membrane molecular weight cutoff were fractionated using charged UF membranes.

Key Words: proteins, membranes, processing

0235 Emerging uses of new dairy ingredients in cheese, yogurt, beverages, and other products. L. Metzger*, *Midwest Dairy Foods Research Center, South Dakota State University, Brookings.*

The application of membrane based filtration processes to isolate and concentrate a variety of protein fractions present in milk has led to the development of a new generation of dairy protein based ingredients. These new protein based ingredients can be broadly classified into three groups: protein isolates containing milk proteins in the same ratio as found in milk, protein isolates fractionated into casein or whey protein; and isolates of individual milk proteins. Protein isolates containing milk proteins in the same ratio as milk have been further modified with enzyme treatments as well as modifications in the mineral content. These modifications have led to improved functionality in process cheese applications, protein bars and UHT processed beverages. Protein isolates that primarily con-

tain casein or whey protein created a new class of ingredients that take advantage of the unique properties of these two categories of protein. For example clear acidic beverages can be produced with whey protein isolates whereas heat stable high calcium meal replacement beverages can be made with casein isolates. Individual protein fractions such as β-casein or α-lactalbumin can also be isolated from milk using a combination of several filtration processes. These individual protein fractions have unique functional or nutritional properties and can be used in produce specialty products such as whipped toppings and beverages that target for stress reduction. The availability of filtration based processes to isolate a wide variety of protein based ingredients containing different fractions of milk proteins in conjunction with enzyme and mineral modification has provided product developers with a tool kit of new ingredients that can be utilized to modify the functionality of existing products as well as create new products.

Key Words: proteins, processing, filtration

0236 An update on carrier and delivery systems using casein micelles from bovine milk. F. Harte*, *University of Tennessee, Knoxville.*

Although the structure-function relationships of casein micelles remain under discussion, there is strong evidence suggesting that casein micelles in bovine milk are natural delivery systems not only for calcium but also for other biomacromolecules. Recent research and development in the structure-function properties of casein micelles has put emphasis on processing operations to improve the binding of low molecular weight hydrophobic molecules. Improved binding properties of casein micelles has been achieved by using enzymatic processes (e.g., transglutaminase) or through environmental modifications including pH, ionic strength, solvent properties, pressure, and shear. Researchers are starting to understand the mechanisms that trigger delivery (e.g., pH, enzymatic digestion) and the role that individual casein proteins play in binding and delivery of bioactives compounds important in the food (e.g., flavor and color delivery), and pharmaceutical (drug delivery) fields. This symposium is designed to update the academic and industry communities on current and future developments on the use of a natural nano-delivery system such as the casein micelles from bovine milk.

Key Words: casein, encapsulation, delivery

0237 Protein modification for health benefits. J. A. Lucey*, *Department of Food Science, University of Wisconsin, Madison.*

Proteins can be modified by the covalent attachment of polysaccharides utilizing the Maillard reaction. Recently, a novel method was developed at University of Wisconsin where conjugation was achieved in (liquid) batch processed mixtures. Protein denaturation/aggregation was inhibited by conducting the process in the presence of a crowding agent (such as dextran). A food-grade chromatography method was developed to purify these conjugates. Conjugated proteins produced by this method had excellent solubility and heat stability and did not exhibit browning or off-flavors. Using an in vitro infant digestion model (i.e., physiological amounts of enzymes that matched in vivo infant digestion rate of β-lactoglobulin), we also demonstrated that conjugated proteins were digested more slowly than unmodified proteins, which could help avoid the high titers of immunoreactive proteins for sensitive infants. We obtained blood sera from patients that had cow's milk protein allergy. The IgE binding capacity of conjugates was tested using the ImmunoCap method. Conjugation of allergenic protein significantly reduced IgE binding but we observed large individual (patient) differences for the level of reduction in IgE binding. Conjugation may be helpful in reducing the allergenicity of food proteins.

Key Words: Maillard, digestion, allergenicity