Dairy Foods Symposium: Advances in Yogurt Manufacture and Product Functionalities

727 The impact of biopolymers on yogurt gelation and properties. J. A. Lucey,* *University of Wisconsin-Madison, Madison.*

Most yogurts in the US contain multiple stabilizers (polymers) that are added to try to control texture during storage. The nature of the interactions between these biopolymers and the milk proteins is poorly understood in yogurt systems. Often manufacturers add several different types of stabilizers in the hope of achieving the desired textural properties. Polymers can be added as stabilizers (e.g., pectin) or can be naturally produced in situ by certain bacteria in the form of exopolysaccharides (EPS). Most cultures supplied for commercial yogurt manufacture in the US contain an EPS-producer. Much confusion exists concerning the precise physico-chemical mechanism(s) by which EPS influences yogurt texture. Complicating factors include: variation in fermentation conditions (e.g., rate of acidification) also affect gel formation, it is not easy to accurately estimate the concentration of EPS in a yogurt matrix; it is usually unknown when in the fermentation process that the EPS was produced (before/during/after gelation), and the nature of the EPS (molar mass, degree of branching, etc) may also influence its interaction with the protein matrix. Better control of the interactions that occur between proteins and polymers during the fermentation process would help manufacturers to tailor-make a product with the desired physical and sensory characteristics. Examples of how different types of biopolymers (e.g., pectins, dextran and EPS) influence yogurt texture will be discussed.

Key Words: yogurt, texture, biopolymers

728 Advancements in yoghurt process design and unit operations. L.-E. Nilsson,* *Tetra Pak, Lund, Sweden.*

Yogurt is one of the fastest growing dairy products in many countries and has been so for many years. Yogurt is produced in different forms such as stirred, set, drink, concentrated, and frozen. Within each type there are many variants, including fat-free, low fat, high-fat, probiotic, prebiotic, lactose-free, mineral enriched, fruit added, fiber-added, etc. The quality of yogurt is influenced by several factors in the process line, most important of which are milk standardisation, deaeration, homogenization, heat treatment as well as culture type and overall plant design. Yogurt milk for stirred and set yogurt is most often increased in dry matter to obtain high viscosity and stability. This can be achieved by powder addition, evaporation or membrane filtration, of which each system has advantages and limitations. The most common fortification method today is powder addition. The basis for manufacture of high quality yogurt is predicated already in the milk treatment. Culture type has a large influence on the final yogurt taste and consistency, but also on the design of the yogurt line. Depending on culture activity in the range of pH 4.3, the design of incubation tanks, pipes, pumps, and cooler etc. are optimized. Some cultures are used which are specially adapted to provide improved functionality to the yogurt. Yogurt coagulum is sensitive to mechanical treatment and due to this fact, plant design is of utmost importance. Calculations of pumps, pipe dimensions, cooler configurations, and process layout must be carefully considered to maintain the natural viscosity built up during fermentation. Concentrated yogurts have recently been increasing in popularity. Traditionally the industry has used specialized separators to remove whey from the yogurt coagulum. Membrane filtration is another technique used for this process. This technique can retain more protein into the finished yogurt and achieve higher yields. Shelf life of yogurt, which is judged by microbiology, appearance, texture and flavor, depends on several factors, from milk quality to filling machine and packaging. There are different ways to extend the shelf life dependent on what limits the shelf life today.

Key Words: yogurt, process design

729 Impact of total solids, protein content, and protein source on the functionality of nonfat yogurt. L. E. Metzger* and K. N. Shah, *Midwest Dairy Foods Research center, South Dakota State University, Brookings.*

In the US, NDM is a commonly used ingredient in yogurt formulations. However, in International markets, skim milk powder (SMP) milk protein concentrate (MPC), and de-proteinized whey are also used in yogurt formulations. The total solids, protein content and source of the protein in a yogurt formulation can affect the functionality of the yogurt. Additionally, physicochemical changes during storage of powders can result in variation of the functional properties of powders as well as of the product in which they are used. The objective of this study was to evaluate the effects of storage of various milk powders (SMP, NFDM, MPC 40, MPC 70) on their functional properties and on the functionality of nonfat yogurt formulations at 3 different protein and total solids levels. Three different lots of SMP, NDM, MPC 40 and MPC 70 were collected from US manufacturers and each lot was divided into 3 portions. A portion was analyzed after 3, 9, and 15 mo of storage at 25°C. At each storage time, yogurt formulations with protein (%)/TS (%) ratios (4/12.5, 4.5/13.5 and 5/15.5) were produced from each lot of SMP, NDM, MPC 40, and MPC 70. The data was analyzed by split plot design using PROC Mixed in SAS. Storage time had a significant effect ($P < 0.05$) on solubility and foaming properties where solubility of MPC70 and foam overrun of SMP, MPC40, and MPC70 decreased significantly ($P < 0.05$) with an increase in storage time of the powders. Emulsification properties of MPC70 were significantly higher ($P < 0.05$) than SMP, NDM, and MPC40. Storage time did not have significant effect on the yogurts from NDM, MPC40, and MPC70 at all protein/TS ratio. Viscosity of both MPC40 and MPC70 yogurts was significantly lower ($P < 0.05$) than SMP and NDM yogurts at each protein/TS ratio. The storage of milk powders has an effect on their functional properties but has a minimal influence on the textural properties of nonfat yogurt, whereas the use of MPC had a substantial effect on the functionality of nonfat yogurt.

Key Words: nonfat yogurt, viscosity

730 Advancements in starter technology and functional benefits in yogurt. DA Romero*[1], C. Fremaux[2], P. Fourcassie[2], S. Huppert[3], and P. Steele[1], *[1]DuPont/Danisco, Madison, WI, [2]DuPont/Danisco, Dangé-St.Romain, France, [3]DuPont/Danisco, Paris, France.*

Yogurt represents one of the oldest forms of biotechnology, employing lactic acid bacteria to ferment milk thus preserving it as a flavorful and healthy food. From the chance contamination of desirable bacteria the industry has progressed to the selection and development of highly specialized strains. Research that began with identifying and characterizing the responsible microbes has progressed to correlating starter metabolism in milk with technological attributes in yogurt. Today we have the

complete genomes for traditional starters *Streptococcus thermophilus* and *Lactobacillus bulgaricus* and a host of probiotics cultures with which to map function to specific genes and pathways. Notwithstanding this revolution of genomics and bioinformatics, research has been grounded in a thorough understanding of microbial bioconversions to deliver rapid and reliable acid, flavor and texture development. In parallel to our increased understanding of starter functionality, there are ongoing and ever sophisticated studies focusing on the role of probiotics; in particular strains belonging to *Lactobacillus* and *Bifidobacterium*. As an excellent vehicle to deliver nutrition and health in food, the incorporation of live microbes to yogurt to provide additional nutrition and health attributes has helped drive the market forward in this age of health conscious consumers. Coupled with current studies of the human gut microflora, the role of probiotics in general wellbeing is transforming to more increasing rigorous scientific investigation in expectation of escalating regulatory expectations. We will present selected examples of strain (e.g., bacteriophage resistance, natural texture and flavor, strain safety) and probiotic (e.g., digestive health, gut transit time, immune health) development to highlight recent advancements and the current state of the yogurt culture development. Further, we will discuss how these technological developments positively affect the demands of the yogurt manufacturer and consuming public.

Key Words: yogurt, starter, probiotic

731 Fine tuning the structure of yogurt by changing the milk properties. M. Corredig,* *University of Guelph, Guelph, Ontario, Canada.*

During fermentation using lactic acid bacteria, as the pH decreases, colloidal calcium phosphate is released from the casein micelles, and the overall charge of the protein is reduced, ultimately causing colloidal destabilization of the protein particles and the formation of a protein network. Although the physico-chemical changes occurring to casein micelles during acidification of skim milk are well understood, the interactions occurring at the molecular level in a yogurt mix are less understood. Such mixes may vary in protein and fat concentrations, contain various stabilizers and different texturizing cultures. This presentation will review the interactions between the important building blocks of structure in acid gels. To better understand these interactions will allow for fine-tuning of the structure. The aggregation of whey protein complexes with caseins and the interactions between caseins and added stabilizers are known to play a major role in texture. The presence polysaccharide produced by lactic acid bacteria also needs to be considered. The interactions between these polysaccharides and milk proteins will vary in the type and extent with time, because of the changes in concentration and environmental conditions, namely pH and ionic strength. Fat globules are also an important building block of the structure and texture of yogurt, and their mode of incorporation in the gel will be modulated by changes to their size and interface. Another important aspect to consider is the pre-concentration of the milk. The processing history of the milk during membrane filtration will affect the gelation behavior of the casein micelles and the interactions between milk proteins. This presentation will provide an overall view of the factors involved in the formation of structure, and identify opportunities to improve or design new processes and product formulations.

Key Words: yogurt, structure, acid gelation