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**DAIRY FOODS SYMPOSIUM:  
PROTEIN FUNCTIONALITY IN CHEESE  
SYSTEMS: NATURAL, PROCESS  
CHEESE AND ANALOGS**

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**0248 Commercial and functional considerations when formulating foods with dairy proteins.**

T. McCarthy\*, *Schreiber Foods, Green Bay, WI.*

Global milk production is estimated at 1600 bn lbs/yr. and cheese production at 45 bn lbs/yr. The dairy industry is among the most highly regulated when it comes to international trade and only about 5% of production is traded internationally. The greatest surpluses of milk being found in New Zealand, US, Germany, France, Australia and Ireland, whereas the greatest deficits are in China, Italy, the Russian Federation, Mexico, Algeria and Indonesia. This presentation will explore some of the commercial and technical challenges in moving dairy proteins around the globe and formulating them into cheese and related products

**Key Words:** milk production, cheese production, markets

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**0249 A model for the formation of the aggregated network in process cheese products that can be used to predict functional properties.** L. Metzger\*, *Midwest Dairy Foods Research Center, South Dakota State University, Brookings.*

Process cheese products are produced by mixing and heating natural cheese and other dairy and non-dairy ingredient in the presence of emulsifying salts. It is well established that during manufacture of process cheese, the para-casein network in natural cheese is modified as a result of calcium chelation by emulsifying salts. This modification results in an increase in the emulsion capacity of the casein and gives process cheese its unique functional characteristics. Extensive research on process cheese has been conducted and the critical formulation parameters (composition, intact casein, calcium content, pH, type and amount of emulsifying salt) and critical manufacturing parameters (mixing speed, cooking temperature, cooking time and cooling rate) have been identified. Although we know these parameters are important, a model that links these parameters to the functional properties of process cheese has not been developed. The objective of this work is to propose a theoretical model to predict the impact of formulation and manufacturing parameters on the functionality of process cheese. The proposed model divides process cheese manufacture into four stages: 1) para-casein network de-aggregation; 2) para casein hydration and induction of casein-fat and casein-casein interactions; 3) casein re-aggregation and gelation; and 4) re-orientation of the gelled network. The

theoretical impact of critical formulation and manufacturing parameters on each stage of the model and their relation to functional properties are also proposed.

**Key Words:** cheese, models, casein

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**0250 Autocatalytic multistage gel formation reaction in dairy based systems in relation to compositional factors.** U. Kulozik\*, *Technische Universität München, Freising-Weihenstephan, Germany.*

A multistage structure formation reaction is described in this paper that seems to be typical for the gel formation process in protein model system similar to products such as fresh cheese or processed cheese. Therefore, it was the objective of this study to identify and to assess the influencing factors driving the reaction. The effect of the fat and protein content, rework as well as the fat globule size influenced by an upstream treatment were studied in this work to develop a deeper understanding of the complex reactions taking place in such systems, where the underlying reaction mechanisms are insufficiently understood so far. It is shown that a fat level of 15-20% is required for the multistage structure formation course to occur. By means of an upstream homogenization of the fat phase and with an increasing protein content, the structure formation can be accelerated. It can be concluded that two parallel or partially sequential reactions seem to take place, inducing the formation of a finely dispersed emulsion as well as a protein network in the continuous phase, the latter one being sourced from proteins at the emulsion droplet interfaces. Compositional factors including the addition of rework affect the structure formation process, rework probably acting as a starter in an autocatalytic reaction.

**Key Words:** gel, protein, fat

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**0251 Protein functionality in processed cheese—Fundamental principles and practical observations.** D. C. Reid\*, *Fonterra Research and Development Centre, Palmerston North, New Zealand.*

Functionality of the protein in the raw materials determines the outcome of processed cheese manufacture. However, making processed cheese is fundamentally an exercise in cost optimization. The biggest cost is the young cheese. This provides unproteolysed casein, sometimes known as intact casein or functional protein, that will form the structural backbone of the processed cheese. Innovation around functional protein is often hindered by cost, regulation or IP. One concept that is often overlooked by manufacturers is optimization of functional protein. Optimizing and standardizing the functional protein not only minimizes the cost of the formulation but increases product quality, increases throughput and reduces rework generation. The challenge is that natural cheese is inherently variable due to proteolysis. Standardization requires measurement of

the functional protein in cheese. There are several approaches to measuring functional protein. Graders can gauge the body of cheese using finger and thumb. Others map the composition of the cheese against its history and predict the maturity. Wet methods are available such as relative casein content or water soluble nitrogen. Gold Peg markets Caseus Pro—a package that combines an NIR-based measurement system with optimization software. Fonterra has been working on a new method that uses viscosity to predict functional protein. To simplify standardization, manufacturers have developed ingredients that are slower to ripen or are more consistent sources of functional protein. One approach is to slow maturation of cheese while another is to use dry proteins. Using powders brings some challenges—not the least of which is hydration in a competitive and moisture-constrained environment. The problem is exacerbated by short processing times in cookers. MPCs have been developed with improved hydration characteristics that help alleviate this problem. Manufacturers have also looked at ways to increase the functional protein value for an ingredient beyond its casein content, for example functionalizing the whey protein component. Fonterra developed an MPC that delivers the same body to processed cheese as rennet casein, despite 20% of the protein being whey. An alternative approach is to functionalize the whey protein during manufacture of the processed cheese. In the future, optimum levels of functional protein could be totally redefined if work with casein fractions comes to fruition. Ingredients enriched in  $\alpha_s$ -casein could deliver significantly more body to processed cheese without compromising other properties.

**Key Words:** intact casein, functional protein, processed cheese

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**0252 Impact of emulsifying salts on milk proteins and process cheese properties.** J. A. Lucey\*, *University of Wisconsin, Madison.*

Emulsifying salts, like citrate and phosphates, are widely used to modify the properties of caseins via a range of chemical and physical reactions. During the manufacture of process cheese, emulsifying salts have the ability to influence several critical events, such as  $\text{Ca}^{2+}$  binding (including complex formation), pH adjustment, casein dispersion (or crosslinking), fat emulsification, and structure formation. The impact of single emulsifying salts on casein properties and process cheese functionality has been studied. However, in many cases confounding effects like pH changes due to variation in the amount/type of emulsifying salt were not addressed in the experimental approach. Trisodium citrate and disodium phosphate are widely used to make many process cheese products whereas pyrophosphates are used for restricted melt applications. Pyrophosphates are very efficient at causing an initial casein dispersion of cheese, but during the heating phase they can cross-link these dispersed caseins to greatly increase viscosity (creaming). Mixtures of emulsifying salts alter casein properties and process cheese functionality in a complex fashion depending on the proportion, concentration and type of emulsifying salts present in these mixtures.

**Key Words:** processed cheese, pyrophosphates, salts