Milk Protein and Enzymes Symposium: Role of Enzymes in Dairy Processing

214 Enzymes in milk—A dynamic system. D. E. Otter*, *AgResearch Ltd., Palmerston North, New Zealand.*

What are they? Where do they come from? Why are they there? How can we use them? The presence of over 70 enzymes encompassing a wide range of activities including lipases, proteinases and lysosomal enzymes have been described in milk. The most highly characterized enzymes include lactoperoxidase, lysozyme, plasmin, lipoprotein lipase and xanthine oxidoreductase. The levels of the different enzymes are species-specific and may relate to the immune maturity of the new-born offspring; for example, in human milk the levels are generally greater than in bovine milk. Milk and colostrum also contain several antimicrobial factors, which exert both specific and non-specific bacteriostatic and bactericidal activity. Enzymes may be present for several reasons, including happenstance, "spill over" from epithelial mammary cells or serum during milk secretion and/or during inflammation or infection of the mammary gland. With the evolution of the lactation process; for example, during cattle domestication and breeding for milk production, it is highly unlikely that their presence is random and indeed some enzymes have essential roles in lactogenesis regulation and are necessary elements of the innate immune system of milk. The enzymes are predominately associated with the MFGM (milk fat globule membrane) and vesicle membranes in milk and the activity of many enzymes can vary significantly due to the metabolic activity of cells, stage of lactation, uninfected or infected glands (mastitis), subclinical infection and inflammation and the hormonal, nutritional and metabolic status of the producing animal (e.g., diet, stress). Enzymes are active in the udder before milk let-down, during the refrigerated storage stage both on the farm and in the factory and may also be present in the final dairy product e.g., plasmin, lipases and phosphatases. They can be exploited in several ways during processing including as an index of the thermal treatment of milk and for consumer health and food safety, e.g., to combat bacterial invasion and growth. The effects of processing and the impact on product quality need to be explored further including the partitioning of enzymes into different milk fractions and the assay methods used to quantify them.

Key Words: enzyme, milk, review

215 Use of phospholipases to modify phospholipid functionality in dairy processing. R. Ipsen*, *Department of Food Science, University of Copenhagen, Frederiksberg C, Denmark.*

Phospholipids (PL), despite constituting only approximately 0.5% of the total lipid in bovine milk, have a critical role in stabilizing milk fat globules against coalescence. They also have different technologic roles in dairy products, e.g., by coating powder particles, providing higher foam volumes in aerated products and acting as co-emulsifiers. In addition, phospholipases can be used to modify phospholipid functionality in dairy processing by improving fat stability or increasing product yield. We have been shown that partial hydrolysis of PL increases cheese yield. In manufacture of part-skim Mozzarella cheese manufactured from milk hydrolyzed with fungal phospholipase A1 before renneting, reduced fat loss in whey and cooking water as well increased cheese yield was found as a result of improved fat and moisture retention. The mechanism of yield improvement due to phospholipases has been found to be complex and not only due to better O/W emulsification of lyso-PL, but also caused by the interaction of lyso-PL with protein and the increased water binding of lyso-PL. When extra phospholipid was added to cheese milk, increased yield also resulted, but the effect of phospholipase was more pronounced than the effect of adding PL. Phospholipase can also be used in the dairy industry to improve the foaming properties of whey protein as we have shown. In general the surface properties of milk and whey are dramatically changed by application of phospholipase and our results have also shown that the reaction between lyso-PL and whey proteins (β-lactoglobulin) increased the heat stability of the whey proteins and show promise for making more heat stable emulsions. It is known that PL influence milk fat crystallization and we have recently started investigating the effect of phospholipase treatment on water-in-oil emulsions of dairy origin. Our preliminary results indicate that the source of milk phospholipids (e.g., buttermilk, whey protein concentrate) has a major effect on the functional behavior.

Key Words: phospholipase, phospholipid, functionality

216 Oligosaccharides from lactose: Enzymatic synthesis and nutritional functionality. M. Gänzle*, *University of Alberta, Edmonton, Canada.*

Oligosaccharides produced from lactose are functional food ingredients to exploit specific biological functions, including low caloric value and prebiotic activity. Galacto-oligosaccharides are synthesized on a commercial scale from lactose by microbial β-galactosidases. Lactose acts as galactosyl-donor as well as galactosyl-acceptor to convert lactose to indigestible oligosaccharides. High lactose concentrations favor oligosaccharides synthesis by β-galactosidases over hydrolysis and high oligosaccharide yields are obtained at lactose concentrations of 30% or higher. Galacto-oligosaccharides are indigestible, stimulate colonic fermentation to short-chain fatty acids, and increase the abundance of intestinal bifidobacteria, and are thus recognized as prebiotic compounds. Transgalactosylation by β-galactosidases with acceptor carbohydrates other than lactose yields a large diversity of oligosaccharides. Lactulose and lactosucrose are produced with fructose and sucrose as acceptor carbohydrates, respectively; both compounds find commercial application as functional food ingredients to stimulate colonic fermentation and to alleviate constipation. *N*-Acetylglucosamine, mannose, fucose, or chitin-oligosaccharides also are galactosyl-acceptors for microbial β-galactosidases to produce novel galactosylated oligosaccharides. Experimental evidence obtained in vitro indicates that galacto-oligosaccharides and related compounds prevent the adhesion of enteric pathogens to mucosal surfaces. Their activity is likely mediated by specific interaction with bacterial glycan recognition proteins that are involved in early steps of pathogenesis. Oligosaccharide synthesis from lactose is an established process to produce galacto-oligosaccharides as functional food ingredients. Health benefits of galacto-oligosaccharides are mainly based on their colonic fermentation to short chain fatty acids. Emerging evidence indicates that lactose can also be used to produce novel oligosaccharides that benefit host health by complementary mechanisms, i.e., the prevention of pathogen adhesion.

Key Words: lactose, β-galactosidase, galacto-oligosaccharide

217 Utilization of enzymes to influence the functionality of milk proteins. U. Kulozik*, *Technische Universität München, Chair for Food Process Engineering and Dairy Technology, Freising-Weihenstephan, Bavaria, Germany.*

The objective of work presented in is paper was to develop new methods for the enhancement of structures in fermented dairy products, to make use of milk proteins in the production of microencapsulated sensitive microorganisms (probiotics) and to produce peptides from milk proteins with functionalities related to bioactivity and surface activity. The report will focus on the following subjects: (1) Strengthening gel firmness in stirred yogurt by Transglutaminase and investigation (avoidance) of structure changes along shelf life, using 3 approaches of enzymatic crosslinking of milk proteins in yogurt milk before fermentation, simultaneously with fermentation, only in supplementary milk used to increase dry matter and protein contents. (2) Microencapsulation of sensitive ingredients and probiotics in enzymatically crosslinked milk protein matrices using an emulsification method producing droplets of highly concentrated dairy proteins containing the core material with subsequently induced crosslinking reaction by Transglutaminase or Chymosin. (3) Selective enzymatic hydrolysis of whey proteins to eliminate individual components based on their individual sensitivity against action of various hydrolyzing enzymes. Targeted enzymatic hydrolysis of whey proteins or enzymatic crosslinking for the production of bioactive peptides, surface active peptides for the manufacture of foams and emulsions, caseinomacropeptide depleted cheese whey with upstream separation of precursor proteins and downstream fractionation of peptide mixtures using novel chromatographic methods

Key Words: transglutaminase, chymosin, trypsin