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IMPROVING THE YIELD OF MOZZARELLA CHEESE BY PHOSPHOLIPASE TREATMENT OF MILK

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Part-skim Mozzarella cheese was manufactured from milk hydrolyzed with fungal phospholipase A_1 prior to renneting. The phospholipase treatment reduced fat losses in whey and cooking water and increased cheese yield as a result of improved fat and moisture retention in the cheese curd. The amount of phospholipids in the whey was reduced because of improved retention of lysophospholipids in the cheese curd. Water binding in the fresh curds and young cheeses up to 3 wk of storage was investigated by a ^1H nuclear magnetic resonance spin–spin relaxation technique. In the fresh curds, 2 dominant water fractions were present, characterized by average spin–spin relaxation times (T_2) of 14 and 86 to 89 ms, respectively. These 2 fractions of low- and high-molecular-mobility water were similar in all cheeses and presumed to represent water associated with the casein matrix and water present in the pores. A few hours after manufacture, cheeses made with phospholipase showed decreased T_2 of the high-mobility fraction, indicating improved water-holding capacity. It is suggested that lysophospholipids released from the fat globule membranes act as surface-active agents in the cheese curd, helping emulsification of water and fat during processing and reducing syneresis. During wk 3 of storage after manufacture, the mobility of both water fractions increased in all cheeses, but was highest in the cheeses made with phospholipase. The increase in mobility during the first weeks of storage has earlier been ascribed to structural changes in the protein matrix, which in principle could be accelerated because of the higher moisture content. However, the microstructure of phospholipase-treated cheese was investigated by confocal laser scanning microscopy and found to be very similar to the control cheese during processing and up to 28 d of storage. In addition, flowability, stretchability, and browning were acceptable and similar in all the manufactured cheeses. Thus, phospholipase hydrolysis of cheese milk improved the cheese yield without changing the cheese microstructure, and resulted in cheese with functional properties that were identical to traditional Mozzarella cheese.

CHEESE pH, PROTEIN CONCENTRATION, AND FORMATION OF CALCIUM LACTATE CRYSTALS

S. Agarwal, J. R. Powers, B. G. Swanson, S. Chen, and S. Clark
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This research investigates the effects of the protein concentration of cheese milk and the pH of cheese on the occurrence of CLC. Atomic absorption spectroscopy was used to determine total and soluble calcium concentrations in skim milk (SM1, 8.7% total solids), and skim milk supplemented with nonfat dry milk (CSM1, 13.5% total solids). Calcium, phosphorus, lactic acid, and citrate were determined in cheeses made with skim milk (SM2, 3.14% protein), skim milk supplemented with ultrafiltered milk (CSM2, 6.80% protein), and nonfat dry milk (CSM3, 6.80% protein). Supplementation with nonfat dry milk increased the initial total calcium in CSM1 (210 mg/100 g of milk) by 52% compared with the total calcium in SM1 (138 mg/100 g of milk). At pH 5.4, soluble calcium concentrations in CSM1 were 68% greater than soluble calcium in SM1. In cheeses made from CSM2 and CSM3, total calcium was 26% greater than in cheeses made from SM2. As the pH of cheeses made from SM2 decreased from 5.4 to 5.1, the concentration of soluble calcium increased by 61.6%. In cheeses made from CSM2 and CSM3, the concentrations of soluble calcium increased by 41.4 and 45.5%, respectively. Calcium lactate crystals were observed in cheeses made from SM2 at and below pH 5.1, whereas CLC were observed in cheeses from CSM2 and CSM3 at and below pH 5.3. The increased presence of soluble calcium can potentially cause CLC to occur in cheese manufactured with increased concentrations of milk solids, particularly at and below pH 5.1.

ACTIVE PACKAGING OF CHEESE WITH ALLYL ISOTHIOCYANATE, AN ALTERNATIVE TO MODIFIED ATMOSPHERE PACKAGING

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The natural antimicrobial compound allyl isothiocyanate (AITC), found in mustard oil, is effective against cheese-related fungi both on laboratory media and cheese. *Penicillium commune, Penicillium roqueforti,* and *Aspergillus flavus* were more sensitive to AITC when it was added just after the spores had completed 100% germination and branching had started on Czapek yeast extract agar than were spores in the dormant phase. The use of 1 AITC label (Wasaouro interior labels, LD30D, 20 by 20 mm) in combination with atmospheric air in the packaging extended the shelf life of Danish Danbo cheese from 4½ to 13 weeks. Two AITC labels extended the shelf life from 4½ to 28 weeks. Both 1 and 2 labels in combination with modified atmosphere packaging extended the shelf life of the cheese from 18 to 28 weeks. This study showed that AITC was absorbed in the cheese, but it was not possible to detect any volatile breakdown products from AITC in the cheese. Cheese stored for up to 12 weeks with an AITC label had an unacceptable mustard flavor. The mustard flavor decreased to an acceptable level between weeks 12 and 28. Cheese stored in atmospheric air had a fresher taste without a CO_2 off-flavor

than did cheese stored in modified atmosphere packaging. AITC may be a good alternative to modified atmosphere packaging for cheese. The extended shelf life of cheese in the package is very desirable: the cheese can be transported longer distances, and the packaging can be used for the final maturing of the cheese. Furthermore, AITC can address problems such as pinholes and leaking seals in cheese packaging.

STORAGE TEMPERATURES NECESSARY TO MAINTAIN CHEESE SAFETY

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Available information on bacterial pathogen growth, stasis, and death in cheeses was reviewed and evaluated to determine storage temperatures necessary to maintain product safety. In view of the variety and large volume of cheeses consumed throughout the world, the incidence of foodborne outbreaks associated with cheeses is extremely low. Research revealed that the inherent characteristics of most cheeses create a hostile environment for bacterial pathogens, especially at elevated ripening and storage temperatures. Therefore, it is recommended that the following cheeses, manufactured in the United States with pasteurized or heat treated (> 63°C for >16 seconds) milk, should be exempt from refrigeration requirements during ripening, storage, shipping, and display: Asiago (medium and old), Cheddar, Colby, Feta, Monterey Jack, Muenster, Parmesan, Pasteurized process, Provolone, Romano, and Swiss/Emmentaler. It must be stressed that the manufacture of these cheeses must be done under the proper conditions of Good Hygiene Practices, Good Manufacturing Practices, and HACCP principles, and according to CFR requirements. In addition, the natural cheeses must include active cultures, and the storage and display temperatures must not exceed 30°C.

FATE OF STAPHYLOCOCCUS AUREUS IN CHEESE TREATED BY ULTRAHIGH PRESSURE HOMOGENIZATION AND HIGH HYDROSTATIC PRESSURE

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They evaluated the influence of ultrahigh pressure homogenization (UHPH) treatment applied to milk containing *Staphylococcus aureus* CECT 976 before cheese making, and the benefit of applying a further high hydrostatic pressure (HHP) treatment to cheese. The evolution of *Staph. aureus* counts during 30 d of storage at 8°C and the formation of staphylococcal enterotoxins were also assessed. Milk containing approximately 7.3 $\log_{10}$ cfu/mL of *Staph. aureus* was pressurized using a 2-valve UHPH machine, applying 330 and 30 MPa at the primary and the secondary homogenizing valves, respectively. Milk inlet temperatures (T_{in}) of 6 and 20°C were assayed. Milk was used to elaborate soft-curd cheeses (UHPH cheese), some of which were additionally submitted to 10-min HHP

treatments of 400 MPa at 20°C (UHPH+HHP cheese). Counts of *Staph. aureus* were measured on d 1 (24 h after manufacture or immediately after HHP treatment) and after 2, 15, and 30 d of ripening at 8°C. Counts of control cheeses not pressure-treated were approximately 8.5 $\log_{10}$ cfu/g showing no significant decreases during storage. In cheeses made from UHPH treated milk at T_{in} of 6°C, counts of *Staph. aureus* were 5.0 ± 0.3 $\log_{10}$ cfu/g at d 1; they decreased significantly to 2.8 ± 0.2 $\log_{10}$ cfu/g on d 15, and were below the detection limit (1 $\log_{10}$ cfu/g) after 30 d of storage. The use of an additional HHP treatment had a synergistic effect, increasing reductions up to 7.0 ± 0.3 $\log_{10}$ cfu/g from d 1. However, for both UHPH and UHPH+HHP cheeses in the 6°C T_{in} samples, viable *Staph. aureus* cells were still recovered. For samples of the 20°C T_{in} group, complete inactivation of *Staph. aureus* was reached after 15 d of storage for both UHPH and UHPH+HHP cheese. Staphylococcal enterotoxins were found in controls but not in UHPH or UHPH+HHP treated samples. This study shows a new approach for significantly improving cheese safety by means of using UHPH or its combination with HHP.

FORECASTING FLUID MILK AND CHEESE DEMANDS FOR THE NEXT DECADE

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The objective was to use current aggregate forecast data, combined with existing econometric models of demand and supply, to forecast retail demands for fluid milk and cheese and the supply and price of farm milk over the next decade. In doing so, they can investigate whether projections of population and consumer food-spending patterns will extend or alter current consumption trends and examine the implications of future generic advertising strategies for dairy products. To conduct the forecast simulations and appropriately allocate the farm milk supply to various uses, we used a partial equilibrium model of the US domestic dairy sector that segmented the industry into retail, wholesale, and farm markets. Model simulation results indicated that declines in retail per capita demand would persist but at a reduced rate from years past and that retail per capita demand for cheese would continue to grow and strengthen over the next decade. These predictions rely on expected changes in the size of populations of various ages, races, and ethnicities and on existing patterns of spending on food at home and away from home. The combined effect of these forecasted changes in demand levels was reflected in annualized growth in the total farm-milk supply that was similar to growth realized during the past few years. Although they expect nominal farm milk prices to increase over the next decade, they expect real prices (relative to assumed growth in feed costs) to remain relatively stable and show no increase until the end of the forecast period. Supplemental industry model simulations also suggested that net losses in producer revenues would result if only nominal levels of generic advertising spending were maintained in forthcoming years. In fact, if real generic advertising expenditures are increased relative to 2005 levels, returns to the investment in generic advertising can be improved. Specifically, each additional real dollar invested in generic advertising for fluid milk and cheese products over the forecast period would result in an additional $5.61 in producer revenues.

EFFECT OF GREEN TEA FLAVONOIDS ON MAILLARD BROWNING IN UHT MILK

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The ability of green tea flavonoids to control Maillard browning was investigated. Epicatechin (EC) and epigallocatechin gallate (EGCG) were added at levels of 0.l and 1.0 mmol/l to a glucose/glycine model system as well as into milk that was then thermally processed in a Microthermics processing system. Samples were assessed with (1) front-face fluorescence spectroscopy for Maillard browning, (2) Hunter *L**, *a**, and *b**; and (3) sensory analysis. In the model gluocose/glycine system, EC and EGCG reduced Maillard fluorescence at the 0.1 mmol/l level, while fluorescence was negligible with added flavonoids at 1.0 mmol/l. When these flavonoids were added to milk, they reduced the production of Maillard associated fluorescence with UHT processing. EC and EGCG also reduced the Ä*E* (Total color difference) during thermal processing. Throughout shelf-life testing, these compounds reduced Maillard associated fluorescence in milk. Milk samples processed with these extracts were monitored by sensory analysis during extended storage. The sensory evaluation found the green tea milk samples to be of similar liking to the control milk. These flavonoids may be of use to the food industry to control Maillard browning.

INTERACTIONS BETWEEN WHEY PROTEIN ISOLATE AND SOY PROTEIN FRACTIONS AT OIL–WATER INTERFACES: EFFECTS OF HEAT AND CONCENTRATION OF PROTEIN IN THE AQUEOUS PHASE

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The objective was to observe the interactions between soy protein isolates enriched in 7S or 11S and whey protein isolate (WPI) in oil–water emulsion systems. Soy oil emulsion droplets were stabilized by either soy proteins (7S or 11S rich fractions) or whey proteins, and then whey proteins or soy proteins were added to the aqueous phase. Although the emulsifying behavior of these proteins has been studied separately, the effect of the presence of mixed protein systems at interfaces on the bulk properties of the emulsions has yet to be characterized. The particle size distribution and viscosity of the emulsions were measured before and after heating at 80 and 90 °C for 10 min. In addition, SDS-PAGE electrophoresis was carried out to determine if protein adsorption or exchanges at the interface occurred after heating. When WPI was added to soy protein emulsions, gelling occurred with heat treatment at WPI concentrations >2.5%. In addition, whey proteins were found adsorbed at the oil–water interface together with 7S or 11S proteins. When 7S or 11S fractions were added to WPI-stabilized emulsions, no gelation occurred at concentrations up to 2.5% soy protein. In this case also, 7S or 11S formed complexes at the interface with whey proteins during heating.