occurred >4 generations back in pedigrees, resulting in one breed with a very large contribution (e.g. 96.9% HO) to the breed composition and the other with a very small contribution (e.g. 3.1% JE). To avoid confusion the data may be reformatted for presentation (e.g. 97HO3JE), which would involve a small loss of precision. When purebred sires are used, the sire breed stack completely describes the mating system and may be used to identify rotational breeding programs. If crossbred sires are used, a four-generation breed stack is needed to identify reciprocal crosses that cannot be denoted by the breed composition alone. Consider a purebred Holstein sire mated to a purebred Jersey cow. Breed composition of a daughter would be 50HO50JE with a sire breed stack of HOJE and heterosis of 1.0. If that daughter were backcrossed to a Jersey bull, the resulting calf would have a breed composition of 75JE25HO, a sire breed stack of JEHOJE, and heterosis of 0.50. This system is necessary to facilitate implementation of across-breed genetic evaluations.

Key Words: Crossbreeding, Genetic Evaluation, Dairy Cattle

537 Effect of strain of Holstein-Friesian cow and grass based feeding systems on milk production, body weight, body condition score and reproductive performance. P. Dillon*[1], B. Horan[1,2], F. Buckley[1], J. Mee[1], and M. Rath[2], [1]*Teagasc, Moorepark Research Centre, Fermoy, Co. Cork, Ireland,* [2]*Faculty of Agriculture, University College Dublin, Dublin, Ireland.*

The objective of this study was to assess the biological efficiency of three strains of Holstein- Friesian (HF) cows in three grass-based systems. For this purpose, 39 High production (HP) North American Holsteins, 39 High durability (HD) North American Holsteins, and 39 New Zealand (NZ) Holsteins were used in three consecutive years. Each strain was allocated to one of three feed systems (FS); high milk output per cow (MP), high concentrate (HC), and high milk output per unit area (HS). Concentrate supplementation averaged 384, 384 and 1,455 kg per cow for MP, HS and HC, respectively. Milk yields were recorded on five days per week, milk composition was determined in one successive morning and evening sample each week. Body weight (BW) was recorded weekly and body condition scores (BCS) every three weeks. Cows were inseminated using AI, over a 13-week period. Milk production, BW, BCS and reproductive data were analysed as a split-plot design, using statistical procedures of SAS. There was a significant strain of HF by FS interaction for milk ($P<0.01$), fat ($P<0.01$), protein ($P<0.01$) and lactose ($P<0.001$) yields. Milk yield response to increased concentrate supplementation was greater with the HP strain. The NZ strain maintained the highest BCS and lowest BW. The HD strain had similar BW to the HP strain, while the BCS of the HD strain was higher than the HP strain ($P<0.05$). Interaction between strain of HF and FS was not significant for the reproductive variables. The HP strain had greater number of services, lower conception rate to first service, and overall pregnancy rate, than both the NZ and HD. The NZ strain had higher conception rate to first and second service, and 6-week in-calf rate than both the HP and HD, while the HD was higher than the HP strain. FS had no effect on reproductive variables. The results indicate that the optimum system of milk production will vary with strain of HF.

Key Words: Dairy Cows, Grazing, Strain By Feed Interaction

Dairy Foods: Cheese

538 Use of reverse osmosis concentrated milk for the manufacture of Cheddar and Colby cheese: Impact on Ca equilibrium and functional properties. M.-R. Lee*, J. A. Lucey, and M. E. Johnson, *University of Wisconsin, Madison.*

The physical characteristics of cheese are governed by proteolysis and electrostatic and hydrophobic interactions as influenced by pH and casein bound Ca (INSOL CA). The objective of this study was to study of the role of Ca equilibrium and pH on functionality changes that occur during ripening. Reverse osmosis (RO) of milk was performed before cheese making which increased the total solids content of cheesemilk by 2%. The additional lactose (0.5%) in RO milk, if fermented, could greatly decrease cheese pH and increase solubilization of Ca. Cheddar and washed curd Colby cheeses were made from RO and non-RO milk with different renneting and draining pH to vary total Ca content of cheeses. Changes in INSOL CA were determined by titration and cheese juice methods. Rheological properties were determined by small amplitude oscillatory rheometry during heating from 5 to 80°C and meltability from UW-Melt Profiler test where the degree of flow at 60°C was determined. The texture of RO Cheddar cheese with low renneting and draining pH was very crumbly (pH dropped to #88044.7). The INSOL CA in cheese decreased during aging in all cheeses. INSOL CA in cheese was positively correlated with cheese pH in both RO ($r = 0.89$) and non-RO ($r = 0.83$) trials. Above pH 4.95, changes in INSOL CA in cheese during ripening were negatively correlated with the maximum loss tangent value (i.e., point when cheese was most fluid-like) ($r = -0.54$) and with degree of flow ($r = -0.56$). Below pH 4.95, there was no significant relation between melting and INSOL CA. These results suggest that for cheese at pH < 4.95, melt was limited and loss of insoluble Ca in cheese during ripening could not improve melt due to dominant effects of low pH on the casein network. In cheeses with pH > 4.95, the reduction of INSOL CA in cheese during ripening contributed to increased meltability.

Key Words: Insoluble Ca, Meltability, Rheology

539 A comparison of three different methods for measuring intact casein in cheese. P Lehtola* and L. E. Metzger, *MN-SD Dairy Foods Research Center, University of Minnesota, St. Paul.*

Intact casein is a fundamental constituent in process cheese because it has important emulsifying properties that significantly affect the texture, stability and melt characteristics of the final product. In the traditional method for measuring intact casein 0.75g of cheese is extracted twice with 25ml of a pH 4.6 buffer. The cheese is dispersed with a high shear mixer, extracted at room temperature for 30 min, and centrifuged. The supernatant obtained is then analyzed for soluble protein using the Kjeldahl method. Intact casein is determined by subtracting the amount of soluble protein from the total protein. The objective of this study was to develop two alternative procedures for measuring intact casein in cheese. In the first new method, 2.5 g of cheese is extracted once with 15 ml of pH 4.6 buffer. As in the traditional procedure, the cheese is dispersed using a high shear mixer, extracted for 30 minutes and centrifuged. Subsequently the supernatant and fat plug is removed and the amount of insoluble protein in the pellet is determined using the Dumas combustion method. In the second new method, .17 g of cheese is extracted once with 1 ml of pH 4.6 buffer. The extraction was performed in a micro centrifuge tube and the cheese was dispersed with a bead blaster. Following centrifugation the pellet was first washed with 1ml of a methanol/acetone solution (75:25) and then washed with 1 ml of acetone. The pellet was then dried in a heating block at 50°C for 1 hr. The final weight of the pellet was determined and used as a measure of insoluble protein. To compare the three methods eight samples of Cheddar cheese were analyzed at 2 wk, 2 months, and 4 months of ripening using each method. Each sample at each ripening time was analyzed in duplicate using each method. All methods observed a significant ($P < .05$) increase in soluble protein and a significant decrease ($P < .05$) in insoluble protein in all samples during ripening. The results of all three methods were highly correlated (>.90). This research has developed two alternative procedures for measuring intact casein in cheese.

540 Vatless manufacture of mozzarella cheese from 8X concentrated microfiltration retentate. A. V. Ardisson* and S. S. H. Rizvi, *Department of Food Science, Cornell University, Ithaca, NY.*

The objective was to compare the functional and viscoelastic properties of low-moisture part-skim LMPS Mozzarella cheeses made by direct acidification with glucono-δ-lactone (GDL) and with starter culture. Both made by a continuous cheese-making process from concentration factor (CF) 8, pH 6.0 skim milk microfiltration retentate (MFR). Pasteurized skim milk was microfiltered to CF 8 at 50C using a 0.1μm nominal pore diameter microfiltration (MF) membrane unit with a total area of 9.2m^2. The system was equipped to maintain a uniform transmembrane pressure (UTMP) of 88.7 KPa. The milk was gradually acidified during MF to pH 6.0 using GDL (1.6g/kg skim milk) to adjust the calcium to casein ratio in the final retentate. The MFR was standardized with cream (40% fat) to produce a cheesemilk (CM) with

a casein to fat ratio of 1.1. GDL (1.7% w/w) or starter culture (1.3% w/w) was added followed by single strength rennet (80lμ/kg CM). CM was converted into cheese curd in an Alcurd continuous coagulator. The resulting curd was then cooked and stretched. The analyses performed on skim milk, retentate, CM and cheeses included total solids, protein (total N, non-protein N and non-casein N), fat and calcium. The cheeses made from MFR were compared to a control for compositional characteristics at day 1, and for functional (meltability and stretchability) and viscoelastic properties at 7, 30 and 60 days of age. All experiments were performed in triplicate.
The fat, moisture and protein contents of the cheeses produced from MFR showed no statistical difference ($p>0.05$) when compared to the control. Viscoelastic parameters (G and G) showed significant differences among the treatments at 7 days of age. However, at 30 days of age, the G and G values for the three treatments coincided at 14.1 kPa and 5.54 kPa, respectively. These trends were similar to those observed for meltability and stretchability, which were different ($p<0.05$) at day 7 but showed no difference at day 30. These results suggest that LMPS Mozzarella cheese can be continuously manufactured from microfiltration retentates and achieve compositional and textural characteristics similar to commercial LMPS.

Key Words: Microfiltration, Mozarella

541 Influence of calcium, phosphorus, residual lactose, and salt-to-moisture ratio on cheese quality: manufacture and composition. P. Upreti*, R. Kapoor, S. K. G. Purna, and L. E. Metzger, *Department of Food Science and Nutrition, MN-SD Dairy Food Research Center.*

Four treatments of Cheddar cheese with two levels (high and low) of calcium (Ca) and phosphorus (P), and two levels (high and low) of residual lactose were manufactured. Each treatment was subsequently split in half and salted at two levels (high and low) for a total of 8 treatments. The 8 treatments included High Ca and P, High lactose, High S/M (HHH); High Ca and P, High lactose, Low S/M (HHL); High Ca and P, Low lactose, High S/M (HLH); High Ca and P, Low lactose, Low S/M (HLL); Low Ca and P, High lactose, High S/M (LHH); Low Ca and P, High lactose, Low S/M (LHL); Low Ca and P, Low lactose, High S/M (LLH); and Low Ca and P, Low lactose, Low S/M (LLL). All cheeses were made using stirred-curd procedure and were replicated three times. Treatments with a high level of Ca and P (HHH, HHL, HLH, HLL) were produced by cutting and drawing the whey at high pH (6.6 and 6.3 respectively), as compared to the treatments with a low level of Ca and P (LHH, LHL, LLH, LLL) (pH of 6.1 and 5.7 respectively). The lactose content in cheeses were varied by adding lactose (2.5% by weight of milk) to the cheese milk for high lactose cheeses (HHH, HHL, LHH, LHL), and washing the curd for low lactose cheeses (HLH, HLL, LLH, LLL). The difference in S/M was obtained by dividing the curds to be salted into two halves, weighing each half, and salting at 3.5 and 2.25% of the weight of the curd for high (HHH, HLH, LHH, LLH) and low S/M cheeses (HHL, HLL, LHL, LLL) respectively. All cheeses were salted at a pH of 5.4. The moisture and fat content of the cheeses ranged from 32.07 to 37.57%, and 33.32 to 35.93%, respectively. The total Ca and P in high Ca and P cheeses was on an average 0.67 and 0.47% Vs 0.53 and 0.39% for low Ca and P cheeses. The amount of residual lactose on the day after manufacture was significantly higher ($P<0.05$) for the high lactose treatments as compared to low lactose cheeses. The S/M for high and low salt cheeses was 6.68 and 4.77% respectively. The manufacturing conditions used in the study produced Cheddar cheeses with desired levels of Ca and P, residual lactose, and S/M.

542 Proteolysis and yield of Cheddar cheeses manufactured from milks with different serum protein contents. B. K. Nelson* and D. M. Barbano, *Northeast Dairy Foods Research Center.*

Our objective was to determine the impact of undenatured serum protein (SP) concentration in milk on proteolysis during Cheddar cheese aging. There were three treatments: control (0.52% SP), reduced SP (0.18%) and increased SP (0.69%). Skim milk was microfiltered (0.1-μm pore size) to 3X in the first stage and then diafiltered twice to 3X using permeate from the UF of permeate from the MF as the diafilterant. The 3X MF retentate after the second diafiltration was diluted to the same casein content as the control milk with the UF permeate that was used as the diafilterant. The increased SP milk was produced by adding SP concentrate from the UF to skim milk. Cream was added to all three milks to achieve a casein-to-fat ratio of about 0.7 and weights were determined for a mass balance of milk components. All manufacturing conditions were held constant for the three treatments and three replicates. The calcium content of the three treatment milks and cheeses were not different, indicating that using UF permeate as a diafilterant and diluent kept the calcium content at the same level as skim milk. There was no difference detected in initial cheese composition among the three treatments. Cheese make time was not affected by the milk SP content. The reduced SP treatment had a higher fat recovery in the cheese than the control or increased SP treatment and this resulted in a higher cheese yield efficiency for the reduced SP treatment. The rate of pH 4.6 soluble nitrogen (SN) production, expressed as a percentage of total nitrogen, was higher (indicating more primary proteolysis) in the cheese made from the reduced SP milk than control or increased SP, but 12% TCA SN was not affected by milk SP content. The ratio of α_s and β-CN to para-κ-CN was lower (17 h of pressing and at 30, 90, and 180 d of aging) in the cheese from low SP content milk. The lower ratio indicated that more CN had been proteolyzed. SP can be removed prior to cheese making without any detrimental impact on cheese composition or proteolysis.

Key Words: Cheddar, Microfiltration, Proteolysis

543 Gel microstructure, permeability and syneresis kinetics of cottage cheese-type gels made under different gelation rates. M. Castillo*[1,2], J. A. Lucey[1], W. Tao[1], and F. A. Payne[2], [1]*Department of Food Science, University of Wisconsin, Madison,* [2]*Department of Biosystems and Agricultural Engineering, University of Kentucky, Lexington.*

Very little is known about syneresis in acid gels or in milk gels made by the combined action of acid and rennet (mixed gels), such as is sometimes used for cottage cheese manufacture. A factorial two-factor experiment with three replications was conducted to study the syneresis kinetics and the relationship between milk coagulation and syneresis at different coagulation rates. Effects of coagulation temperature and inoculum concentration on the microstructure and permeability of these mixed gels were also investigated. Coagulation parameters were concurrently monitored using rheology tests and near infrared light backscatter. Coagulation factors, such as inoculum level and temperature, had a direct effect on the development of the casein matrix, which impacted the physical characteristic of gels (e.g. particle rearrangement, permeability coefficient). These physical characteristics affected the extent and kinetics of the syneresis process. Whey drainage and curd shrinkage in mixed gels followed a first order kinetic reaction. The effect of temperature on kinetic rate constant for whey drainage allowed us to estimate both the thermal coefficient and the activation energy. A strong correlation was observed between syneresis parameters and those parameters characterizing acidification and network formation, which showed that coagulation kinetics played an important role in the syneresis process of mixed gels. Whey expulsion with time was predicted using a model that consisted of temperature and light backscatter parameters with an R^2 of 0.96. This suggests that it may be possible to develop a sensor capable of monitoring both coagulation and syneresis process, which could lead to greater control of the curd moisture content and an improvement of the final cheese homogeneity and quality.

Key Words: Syneresis Kinetics, Permeability, Cottage Cheese

544 Sensory differences among Pecorino Siciliano cheeses by geographic origin. J. Horne[1], S. Carpino*[1], S. Mallia[1], A. Difalco[1], G. Tumino[1], and G. Licitra[1,2], [1]*CoRFiLaC, Regione Siciliana, Ragusa, Italy,* [2]*D.A.C.P.A. Catania University, Catania, Italy.*

Pecorino Siciliano is a PDO ewes' milk cheese produced in Sicily. The current study was undertaken to determine if location of production affects sensory properties of the cheese. Four months' ripened cheeses, respecting the traditional shape, were obtained from 15 farms from throughout Sicily that were classed into four groups by geography. Sensory characteristics were measured using a MS-based Electronic Nose (EN) and by a trained sensory panel. EN data were collected from a SPME extraction of volatile organic components from each cheese and from five sterile processed cheese blanks. A MS-based Electronic Nose (SMartNose) was used to detect volatiles in the mass-to-charge (m/z) range of 10 to 130 amu. Stepwise discriminant analyses followed by discriminant factor analyses on standardized data sets with and without five air samples found a group of mid-range masses that efficiently

separated cheeses by area of production along east-west axes. A few high-range masses were also important discriminators. Sensory panelists were likewise able to discriminate between cheeses produced in different areas of Sicily: western cheeses had stronger floral, fruity and mushroom/earthy aromas and eastern cheeses had stronger aroma intensities, butyric and spicy aromas. Eastern cheeses were also saltier, harder and less moist. Principal components analysis on the sensory data separated cheeses by area with an east-west axis on PC1 (58%) and a separation between northeastern and southeastern Sicily on PC2 (17%). Both EN and traditional sensory analysis found similar differences among cheeses. While EN technology is simpler and faster to use, especially if there are a lot of samples, the human nose is probably still superior in detecting subtle differences.

Key Words: Pecorino Siciliano, Electronic Nose, Sensory Analysis

545 Differences between milled curd and stirred curd Cheddar cheese manufactured with different culture/enzyme systems. S. Rehman*[1], N. Farkye[1], and M.A. Drake[2], [1]*Dairy Products Technology Center, California Polytechnic State University, San Luis Obispo,* [2]*Southeast Dairy Foods Research Center, North Carolina State University, Raleigh.*

The quality of Cheddar cheese made by stirred or milled curd methods are presumably different. This study was undertaken to minimize quality differences in Cheddar cheese due to method of manufacture by evaluating the effects of culture and ripening temperature on Cheddar cheese. Three replicate experimental cheesemaking trials (by both milled and stirred curd methods) were conducted using specific culture systems supplied by four commercial culture companies. On each cheesemaking day, two 625 kg lots of milk were made into Cheddar cheese with one culture system by each method. Cheese curds in18.2kg blocks were pressed overnight in a vacuum chamber with 24 mmHg for first 60 min. Cheeses were ripened at 2 or 8°C and sampled at intervals for starter and non-starter lactic acid bacteria (NSLAB), and proteolysis. Sensory analysis was done at 3, 6 and 9 months by a panel (n=6) and 12 industry graders. Growth of starter or NSLAB was not effected by the method of manufacture (P>0.01). Proteolysis and the sensory attributes diacetyl, sour and salty were influenced by method of manufacture. The culture system affected cell density of NSLAB and the sensory attributes cooked, whey, sulfur, brothy, milkfat, umami and bitter while only brothy flavor was influenced by storage temperature.

Key Words: Cheddar Cheese, Milled and Stirred Curd, Culture

546 Influence of brine concentration, brine temperature, and presalting on early gas defects in raw milk pasta filata cheese. C. Melilli*[1], D. M. Barbano[2], M. Caccamo[1], M. A. Calvo[1], G. Schembari[1], and G. Licitra[1], [1]*CoRFiLaC, Regione Siciliana, Ragusa, Italy,* [2]*Northeast Dairy Food Research Center, Department of Food Science, Cornell University, Ithaca, NY.*

Thirty one 3.8-kg experimental blocks of Ragusano cheese were made on each of 6 days. On days 1, 3, and 5 cheeses were not presalted while on days 2, 4, and 6 cheeses were presalted. One block was analyzed prior to brine salting. Blocks (15) were placed in 18% brine and the other 15 into saturated brine. For the 15 blocks within each of the two brine concentrations (BC), 5 blocks were placed in a brine at 12°C, 5 at 15°C, and 5 at 18°C. One block was removed from each brine tank after 1, 4, 8, 16, and 24 d, weighed, sampled, and analyzed for composition, coliform count, and gas production. Presalting the curd with 2% salt before stretching reduced the coliform count in the cheese by 1.41 log and made a major reduction in early gas formation. Gas production was measured by image analysis of cheese slices to determine the percent of the surface area of the slice occupied by gas holes. Across all treatments the largest reduction in gas formation (ca. 75%) was due to presalting. Reducing brine temperature (BT) had the second largest impact on reducing gas production, but did not reduce the coliform count in the cheese. Reducing BT from 18 to 12°C made a larger reduction in gas formation in cheeses that were not presalted (from 6.8 to 1.8% gas holes, respectively) than in cheeses that were presalted (from 1.9 to 0.5% gas holes, respectively). To achieve the same absolute level of gas production in the cheese that was not presalted, as was achieved by the combination of presalting and 18°C brine, the BT had to be lowered from 18 to 12°C. Reducing BC, while it improved salt penetration, did not have any impact on coliform count and had minimal impact on reducing gas production. Reducing BC, while it improved salt penetration, did not have any impact on coliform count. BC did not affect gas production at BT of 12 and 15°C. The amount of gas holes were not different from 0 to 16 d but were higher at 24d in saturated brine at 18°C than in 18%B at 18°C.

Key Words: Early Gas, Coliform, Presalting

547 Direct acidification and cream homogenization for Mozzarella cheese manufacture. K. J. Ottman and L. E. Metzger*, *Department of Food Science and Nutrition, MN-SD Dairy Food Research Center, University of Minnesota, St. Paul.*

The effect of direct acidification, cream homogenization and non-fat dry milk addition on Mozzarella cheese composition and functionality were determined. Four vats (16 kg of milk per vat) of cheese were made with no direct acidification (control), direct acidification with acetic acid (DA), direct acidification with acetic acid and homogenized cream (DH), and direct acidification with acetic acid, homogenized cream and addition of non-fat dry milk (DHNF). Cheese curd produced in the direct acidification treatments was stretched in a process cheese twin screw cooker to 70°C whereas the control was stretched by hand in a hot brine solution to a temperature of 60°C. Cheese manufacture was replicated three times on different days. The direct acidification treatments had a significantly (P<.05) lower calcium content as compared to the control. The DA treatment had significantly higher (P<.05) fat losses as compared to the control. However, when cream homogenization was used in conjunction with direct acidification (DH and DHNF), the cheese produced had a similar (P>.05) fat content and fat recovery as compared to the control. Non-fat dry milk addition (DHNF) resulted in the highest actual and adjusted yield. The control treatment had a significantly higher level of pH 4.6 and 12% TCA soluble nitrogen throughout 90 d of refrigerated storage as compared to the direct acidification treatments (DA, DH and DHNF), which remained relatively stable. The direct acidification treatments had less proteolysis due to the lack of starter culture and higher stretching temperature. The control had an increase in meltability during the first 30 d and then remained stable throughout refrigerated storage whereas the direct acidification treatments remained stable throughout storage. The DA treatment had the greatest meltability and the DHNF treatment had the least meltability at 30, 60, and 90 d of refrigerated storage. This study demonstrates that direct acidification in conjunction with cream homogenization and a high temperature during stretching can be used to produce Mozzarella cheese with targeted functionality immediately after manufacture and throughout 90 d of refrigerated storage.

548 Effects of 6 month extended frozen-storage on changes in organic acid profiles of plain soft and Monterey Jack goat milk cheeses. Y. W. Park*, J. H. Lee, and I. C. Blackman, *Fort Valley State University, Fort Valley, GA.*

Maturation processes of cheeses are not well understood for most varieties because of the heterogenous nature of the product. Although organic acid composition is greatly related to the acceptability of goat milk cheeses, few reports are available on this premise. Three lots of plain soft (PS) goat cheeses were purchased, and 3 lots of Montery Jack (MJ) goat cheeses were manufactured at the University dairy plant to study changes in organic acid profiles during 6 months of extended frozen and refrigerated storage. Each cheese variety was subdivided into 4 equal portions. One portion was stored at 4°C for 4 weeks (0, 14, 28 days) as the unfrozen control (UFC), and the other three subsamples were frozen (-20°C) and stored for 0, 3 and 6 months (FZC, 3FZ and 6FZ), then immediately thawed the next day at 4°C, followed by aging at 4°C for 4 wks. Organic acids were assayed using a HPLC (Hewlett Packard; LC-1100 Series) equipped with auto sampler and diode array UV detector. The column was reverse phase Hewlett Packard ODS Hypersil 5μm (125 X 4 mm), and solvent was 0.5% (wt/vol) $(NH_4)_2HPO_4$. Differences in organic acid contents between soft and MJ cheeses were significant (P<0.01 or 0.001) for all acids except citric and lactic acid. Lot effect was significant (P<0.01) for most of the known acids, indicating that some variations might have occurred in milk composition and manufacturing processes. Effects of storage treatments (UFC, FZC, 3FZ and 6FZ) were highly significant (P<0.01 or 0.001) for most organic acids, except for orotic and a few unidentified acids. Aging at 4°C for 4 weeks had little influence on all organic acids except butyric acid. Concentrations of butyric, lactic, propionic, tartaric and uric acids were significantly (P<0.01) elevated as the frozen-storage period advanced.

Although several organic acid levels were elevated in the goat cheeses, prolonged frozen-storage upto 6 months may be feasible because no apparent deterioration in sensory scores were observed in other companion studies.

Key Words: Goat Cheese, Frozen-Storage, Organic Acids

549 Interaction of emulsifying salts with milk proteins. R. Mizuno*[1,2] and J. A. Lucey[2], [1]*Food Research & Development Laboratory, Morinaga Milk Industry Co., Japan,* [2]*Department of Food Science, University of Wisconsin, Madison.*

Emulsifying salts (ES) are used for process cheese production, however, it is not completely understood how ES influence the physical and chemical properties of process cheese. The purpose of this study was to understand the interactions between ES and milk proteins using a simple model system. In this system, milk protein concentrates (MPC) solution was used as the source of milk protein and the effects of addition of ES upon milk protein were estimated by measuring the area of acid-base titration curves, turbidities, and the amount of soluble calcium. Various concentrations (0 to 0.7% (w/w)) of ES (trisodium citrate or sodium phosphates (ortho-, pyro-, or poly-)) were added to MPC solution (5% (w/w) solids). The pH of all solution was adjusted to 5.8 using hydrochloric acid after addition of ES (to be in the typical pH range of process cheese). The area of the titration curves was measured using the acid-base buffering method to observe changes in the amount and type of colloidal calcium phosphates (CCP). Turbidity measurements were made at 600 nm and the amount of soluble calcium was determined by measuring the calcium concentration that was ultrafilterable. An increase in the concentration of trisodium citrate brought about a decrease in the buffering capacity contributed by CCP, a decrease in the turbidity, and an increase in the amount of soluble calcium. Orthophosphates had little effect on the titration curves, turbidity, and the amount of soluble calcium. With increasing addition of pyrophosphates, the buffering capacity, turbidity, and amount of soluble calcium decreased. With the addition of a small amount polyphosphates, the effects were similar to those of pyrophosphates but when excessive amounts were added, there was a shift in the pH where the peak of the titration curve caused by CCP occurred, and an increase in the amount of soluble calcium. These results suggest that each ES influences milk proteins with different mechanisms.

Key Words: Emulsifying Salt, Milk Protein, Colloidal Calcium Phosphates

550 Impact of type of concentrated sweet cream buttermilk on the manufacture and functionality of pizza cheese. T. Y. Lin[1], S. Govindasamy-Lucey*[2], J. J. Jaeggi[2], C. J. Martinelli[2], M. E. Johnson[2], and J. A. Lucey[1], [1]*Department of Food Science, University of Wisconsin, Madison,* [2]*Wisconsin Center for Dairy Research, University of Wisconsin, Madison.*

Sweet cream buttermilk (SCB), a by-product of buttermaking, is a rich source of phospholipids, which could assist in fat emulsification. Most SCB is sold concentrated and it is not clear how the different concentration processes affect the behavior of SCB as an ingredient in cheese. SCB was concentrated by cold (<7C) ultrafiltration (UF), cold reverse osmosis (RO) or evaporation (EVAP). A washed, stirred-curd cheese was manufactured from the three different types of concentrated SCB. Cheesemilks of CN:fat ratio of 1.1 and final CN content 2.7% were obtained by blending UF-SCB retentate (19.5% TS), RO-SCB retentate (22.0% TS) or EVAP-SCB retentate (37.6% TS) with partially-skimmed milk. Control cheese was made with partially-skimmed milk (11.3% TS). Cheese functionality was assessed using dynamic low-amplitude oscillatory rheology (DLAOR), UW Melt Profiler (extent of flow after heating to 60C) and on pizza. Initial trials with SCB fortified cheeses resulted in 4% higher moisture (51-52%) than control cheese (46-47%). In subsequent trials procedures were altered to obtain similar moisture content in all cheeses. Fat recoveries in cheeses were lower with SCB fortified milks than with control milks. Nitrogen recoveries in cheeses made with control milks were slightly higher than in cheeses with RO-SCB and EVAP-SCB milks; but lower than UF-SCB milk cheeses. Total phospholipids recovered in SCB-cheeses (28-34%) were lower than control (42%). From DLAOR test, the loss tangent curves at temperatures > 40°C increased as cheese aged up to a month and were lower in SCB-cheeses than control. Extent of flow was higher for control cheese than SCB-cheese and as cheese ripened, it increased for all cheeses. TCA-soluble nitrogen levels were slightly lower in SCB fortified cheese than control. On baked pizza, UF-SCB fortified cheese had lowest amount of free oil but flavor attributes of all cheeses were similar. Addition of concentrated SCB to standardize cheesemilk for pizza cheese lowers free oil without adversely affecting functional properties of cheese but could increase cheese moisture, unless corrected.

Key Words: Sweet Cream Buttermilk, Pizza Cheese, Melt

551 Effect of fat content on rheological and melting properties of Mozzarella cheese. C. Udayarajan* and J. Lucey, *Department of Food Science, University of Wisconsin, Madison.*

Melting properties of Mozzarella cheese are influenced greatly by its chemical composition. The objective of this study was to evaluate the influence of various fat levels on rheological and melting properties of Mozzarella while maintaining similar moisture content. Mozzarella cheeses with low (30%), medium (40%) and high (50%) fat in dry matter (FDM) were manufactured. Cheeses properties were analyzed on day 2, 7, 14, 21 and 28. Rheological properties were studied using Fourier Transform Mechanical Spectroscopy (FTMS), which is a type of small amplitude oscillatory rheometry. Using FTMS the data for a wide range of frequencies (0.08-8 Hz) were collected in real time while cheese sample was heated over a temperature range from 10 to 90°C at 1°C/min. Storage modulus (G′) and loss modulus (G″) increased with frequency for all cheeses and the differences between frequencies were more evident at higher temperatures. Both G′ and G″ were lower with an increase in fat content and their values at high temperatures decreased with increasing cheese age. During heating all three cheeses exhibited a maximum in loss tangent (Max_{tan}) and the value of Max_{tan} decreased as the frequency increased. Maxtan increased with an increase in fat content and ripening period. Melting properties like extent of flow at 60°C and melt area were analyzed using UW Melt profiler and Schreiber test, respectively. Meltability improved as the fat content increased. Extent of flow increased for all cheeses from day 2 to 21 and then hardly changed. There was a significant correlation between extent of flow and Max_{tan}. Melt area was higher for medium and high FDM cheeses compared to low FDM cheese. Melt area increased with age for medium and high FDM cheeses up to day 14 and then declined. Melt area did not change during ripening for low FDM cheese. Rheological results correlated well with the pizza bake test in which the low FDM cheese blistered and blackened and did not flow. Excessively strong protein interactions in the high protein (low FDM) cheese were responsible for its poor meltability. Strategies are needed to reduce the strength of protein interactions if improved meltability is required.

Key Words: Mozzarella, Rheology, Melt

Extension Education - Animal Science

552 Beef development costs. W. Ellis*, *Southeast Missouri State University, Cape Girardeau.*

The objective of the study was to determine the cost of beef heifer development from weaning to her first parturition. The study was conducted at Southeast Missouri State University Farm. Data were obtained from thirty-one Angus or Angus cross heifers born in the fall of 2000. Heifers were weaned in April of 2001, bred in November of 2001, and calved in fall of 2002. Heifer development followed the guidelines of the Missouri Show-Me-Select Replacement Heifer Program, which is an educational program involving comprehensive guidelines for beef replacement heifer development and marketing. Program development included pasture, feeds, labor, vaccinations, pre-breeding reproductive tract score, estrus synchronization, artificial insemination (AI), clean-up bull, pregnancy testing, and cost of open heifers. Mean weight and age (Mean SE) of heifers at weaning and at beginning of the breeding season were 203.7 ± 2.9 kg, 205.6 ± 3.2 days, 370.4 ± 4.9 kg, and 405.6 ± 3.2 days, respectively. Mean pre-breeding reproductive tract score was 4.9 ± .04 indicated 31/31 (100%) of the heifers reached puberty and cycling before breeding season. First AI service pregnancy rate following estrus synchronization treatment was 22/31 (71%) and pregnancy rate after