

Dairy Foods Cheese

357 Comparison of effect of vacuum condensed and ultrafiltered milk on pasteurized Process cheese. M. R. Acharya* and V. V. Mistry, *MN-SD Dairy Foods Research Center, South Dakota State University.*

Milk was concentrated by ultrafiltration (UF) or vacuum condensing (CM) and milks with two levels of protein: 4.5% (UF1 and CM1) and 6.0% (UF2 and CM2) for concentrates and a Control (C) with 3.2% protein were used for manufacturing five replicates of Cheddar cheese as discussed earlier (Acharya et al. 2001. *J. Dairy Sci.* 84 (Suppl.1):306). For manufacturing pasteurized Process cheese a 1:1 blend of shredded 18-week and 30-week Cheddar cheese, butter oil and disodium phosphate (3%) was heated and pasteurized at 74°C with direct steam injection. The moisture content of the resulting Process cheeses was 39.4 (C), 39.3 (UF1), 39.4 (UF2), 39.4 (CM1) and 40.2% (CM2). Fat and protein contents were influenced by both level and method of concentration of cheese milk. Fat content was the highest in C (35.0%) and the lowest in UF2 (31.6%), whereas, protein content was the lowest in C (19.6%) and the highest in UF2 (22.46%). Ash content increased with increase in level of concentration of cheese milk with no effect of method of concentration. Meltability of Process cheeses decreased with increase in level of concentration and was higher in C than the concentrates. Hardness was highest in UF cheeses (8.45 kg-UF1 and 9.90 kg-UF2) followed by CM cheeses (6.27 kg-CM1 and 9.13 kg-CM2) and C (3.94 kg). Viscosity of molten cheese at 80°C was higher in 6.0% protein treatments (1043 cp-UF2 and 1208 cp-CM2) than in by 4.5% protein treatments (855 cp-UF1 and 867 cp-CM1) and in C (557 cp). Free oil in Process cheeses was influenced by both level and method of concentration with C (14.3%) being the lowest and CM2 (18.9%) the highest. Overall flavor, body and texture, and acceptability were significantly higher for Process cheese made with the concentrates compared to control. This study demonstrates that the application of concentrated milks for Cheddar cheese making has an impact on Process cheese characteristics. The type of concentration technique (UF or CM) also is a factor.

Key Words: process cheese, ultrafiltration, condensing

358 Comparison of three methods to quantify water soluble calcium in Mozzarella cheese. 2. Effect of short-term aging. M.A.S. Cortez¹, M.M. Furtado¹, and P.S. Kindstedt*², ¹Federal University of Vicosa/CAPES, MG/Brazil, ²University of Vermont, Burlington, VT/USA.

Previous studies have shown that the concentration of water soluble (WS) Ca in the expressible serum (ES) from Mozzarella cheese may increase during the first 2 wk after manufacture. This study compared WS Ca measurements obtained by two different dilute WS extract methods (M1, Metzger et al. (2001) *J. Dairy Sci.* 84:1357; M2, Kuchroo and Fox (1982) *Milchwissenschaft* 37:331), and one ES method (M3, Guo and Kindstedt (1995) *J. Dairy Sci.* 78:2099) during short-term aging of Mozzarella cheese. A cultured low-moisture part skim Mozzarella cheese was obtained from a commercial manufacturer on the day after manufacture and stored at 4°C. Six WS extracts (M1, M2) and six ES samples (M3) were prepared from replicate cheese samples at 3, 6, 9, and 12 d after manufacture, and then analyzed for total solids and crude protein, pH, Ca, P, and Na, concentrations. The data were analyzed according to a split-plot CRD to evaluate the effects of method and storage time on the measurements. WS Ca was affected significantly by method, storage time, and their interaction. Mean WS Ca values, expressed as percentage of total Ca, for the three methods were # d 3: M1 = 38%, M2 = 30%, M3 = 21%; d 6: M1 = 36%, M2 = 28%, M3 = 23%; d 9: M1 = 38%, M2 = 31%, M3 = 26%; d 12: M1 = 36%, M2 = 29%, M3 = 28%. WS Ca increased significantly during storage when measured by M3 but did not change significantly by M1 or M2. WS P increased significantly during storage when measured by M3 but decreased significantly by M1 and M2. The pH of the WS extracts (M1, M2) and ES (M3) was affected significantly by method, storage time, and their interaction. The pH of the M1 WS extract was higher than the cheese pH due to a dilution effect, whereas the pH of M2 extract was lower, due to fermentation during the preparation of the extract. The pH of WS extracts (M1, M2) increased more during aging than the pH of ES (M3). The differing pH

profiles during extraction may have affected WS Ca measurements and contributed to inconsistent results among methods.

Key Words: Mozzarella cheese, Soluble calcium, aging

359 Reduction of losses of salt (NaCl) during the manufacture of cheddar cheese. S. S. Nair* and V. V. Mistry, *MN-SD Dairy Foods Research Center, South Dakota State University.*

One part of pasteurized, separated milk (0.58% fat) was ultrafiltered (55°C, 16.0% protein), another vacuum condensed (12.5% protein) and a third was not concentrated. Cheddar cheese was manufactured using six treatments by standardizing unconcentrated milk to a casein/fat ratio of 0.74 with unhomogenized 35% fat cream (C); homogenized (6.9 MPa/3.5 MPa) 35% fat cream (CH); unhomogenized cream and ultrafiltered milk (UF); homogenized cream and ultrafiltered milk (UFH); unhomogenized cream and condensed milk (CM); and homogenized cream and condensed milk (CMH). C and CH had 3.7% fat and 3.5% protein and the respective values in the remaining treatments were 4.9 and 4.6. Starter (DVS, 7g/kg protein) and rennet (20 ml/100 L for C, CH or 14 ml/100 L for UF,UFH,CM,CMH) were added. Cooking temperature (°C) was 37 for C and CM, 39 for CH, 36 for UF, and 38 for UFH and CMH. Salting (2.7% by weight of milled curd) was done in three equal portions each with three minutes mixing. Fat in whey ranged from 0.16 to 0.35%, and protein from 0.91 to 1.27%. Fat in salt whey ranged from 0.39 to 1.34%, protein from 1.22 to 1.45%, and salt from 6.27 to 8.99%. Moisture content was lowest in the UF and CM cheeses (36.0 and 35.7%) but increased to 36.9 and 37.1% by homogenization. Salt content in the control and ultrafiltered milk cheeses was dependent on homogenization (1.33%, C; 1.83%, CH; 1.33%, UF; 1.70%, UFH). Salt retention was higher in condensed milk cheeses than in those from ultrafiltered milk or control and was not affected by homogenization (1.62%, CM; 1.64%, CMH). Salt recovery in cheese increased from 41.9 in C to 59.9% in CH, and from 41.8 in UF to 54.7% in UFH. The increase was smaller for condensed milk cheeses (50.8 in CM to 52.3% in CMH). For control and ultrafiltered milk cheeses the percentage salt in salt whey was lower with homogenization as was the total amount of salt whey generated. The higher retention of salt due to homogenization may be due to higher resistance to the movement of sodium chloride in the protein-fat matrix.

Key Words: Cheddar cheese, Homogenization, Salt recovery

360 The role of physicochemical properties in governing cheese texture. J.A. Brown*, E.A. Foegeding, M. Drake, and C. Daubert, ¹North Carolina State University.

Cheese is a popular food due to its diversity in application, nutritional value, convenience, and good taste. Producing high quality cheeses that meet consumer expectations is crucial in order for cheesemakers to remain competitive. These expectations include end-use functionality (shred, melt, stretch, etc.) and proper texture. Currently, there is not a clear understanding of what characteristics govern these aspects. This study seeks to define physical properties of young cheeses in order to understand their role in perceived cheese texture. Mozzarella and Pizza cheeses were tested at 4, 10, 17, and 38 days of age; processed cheese was also included. Rheological methods were employed to determine the viscoelastic, non-linear, and fracture properties of the cheeses. A trained sensory panel developed appropriate descriptive language and product-specific reference scales to evaluate cheese texture. Both sensorial and rheological methods differentiated the cheese varieties, and patterns were observed as the cheese aged. Rheological analysis showed the cheeses were viscoelastic gels with greater storage (G' , elastic) than loss (G'' , viscous) moduli. The overall magnitude of G' decreased as the cheeses aged; creep recovery analysis confirmed the loss of overall firmness with time. Five sensory terms differentiated the ages of the cheeses within varieties. Correlations between the sensory and rheological methods were observed, and the predictive nature of such measurements on cheese texture was evaluated. Principle component analysis revealed that sensory evaluation alone was better able to order the cheeses according to age than the when only combinations of rheological methods were used; combinations of both methods chronologically placed the cheeses. These results have significant implications in the cheese industry; by understanding how texture changes during the early stages of

aging, cheesemakers can custom make cheeses with specified textures more accurately. Future testing should focus on how such parameters affect end-use functionality in order develop similar models which will help cheesemakers to meet consumer demands.

Key Words: Cheese Texture, Rheology, Sensory

361 Effect of adding yeast extract on proteolysis and flavor development of reduced fat Cheddar cheese. Shakeel Rehman^{*1}, Nana Farkye¹, Eba Vedamuthu², and MaryAnne Drake³, ¹*Dairy Products Technology Center, California Polytechnic State University, San Luis Obispo, CA 93407*, ²*994 NW Hayes, Corvallis, OR, 97330*, ³*South East Dairy Research Center, North Carolina State University, Raleigh, NC 27695*.

Yeast extract is used as a nutrient for growing lactobacilli. The growth of non-starter lactic acid bacteria (NSLAB) in Cheddar cheese is suppressed by pasteurization of milk and hostile environment of Cheddar cheese. This study was undertaken to determine the effect of adding yeast extract to reduced fat Cheddar cheese curd to promote growth of NSLAB for enhancing flavor. Cheese was manufactured from 100 kg standardized milk on two occasions. After milling, the curd was divided into two portions, C and E. To control portion, C, salt was added at normal levels. A mixture of salt and yeast extract was added to the experimental, E. The cheeses were ripened for 7 months at 8C. One week-old cheeses were analyzed for gross composition. NSLAB were enumerated during ripening. Proteolysis was assessed by urea-polyacrylamide gel electrophoresis (PAGE) of the cheeses and by determination of water soluble N (WSN) and concentration of total free amino acids. A 6-member trained descriptive sensory analysis panel evaluated flavor attributes. Mean % moisture, fat, protein, salt-in-moisture and pH were 40.8, 20.5, 31.1, 4.2 and 5.22 respectively, in E cheeses, and 39.5, 20.5, 30.9, 3.3 and 5.22, respectively, in C cheese. NSLAB counts in E cheeses were 10^1 , 10^3 , 10^5 , cfu / g compared to 0, 10^1 , 10^4 cfu / g in C respectively, after 1, 7 and 30 days of ripening. After 60 days, cell densities of NSLAB were similar (10^6 cfu/g) in C and E cheese. Addition of yeast extract to curd did not influence primary proteolysis. The total free amino acids were significantly higher in E cheese than C cheese throughout ripening, suggesting faster secondary proteolysis in the former cheeses. The sensory panel perceived that the E cheeses had higher intensities of whey, fruity, sulfur, nutty, sweet and sour flavors, but had lower intensities of brothy flavors as compared to C cheeses. Also, the E cheeses were perceived to be more mature than corresponding C cheese. Results show that the use of yeast extract in the manufacture of Cheddar cheese increases the secondary proteolysis and improves flavor.

Key Words: yeast extract, reduced fat Cheddar, NSLAB

362 Effect of pH on chemical and functional properties of cheese. A.J. Pastorino¹, C.L. Hansen¹, and D.J. McMahon^{*1}, ¹*Western Dairy Center, Utah State University*.

Our objective was to determine the effect of pH on chemical and functional properties of cheese. Commercial Cheddar cheese (34% moisture, 30% fat, 1.7% salt, 0.8% calcium) was obtained on 1 d and cut into 0.4 to 0.5-kg blocks that were vacuum packaged and stored for 14 d at 4C. Cheese blocks were then high-pressure injected 1, 3, or 5 times, with a 20% (wt/wt) glucono-delta-lactone solution. Successive injections were performed 24 h apart. After 40 d of storage at 4C, cheese blocks were analyzed for chemical and functional attributes. Injection of glucono-delta-lactone solution decreased cheese pH. After 5 injections, cheese pH was 4.7 compared to 5.3 in the control, uninjected cheese. Decreased pH increased the content of soluble calcium and decreased the total calcium content of cheese. At the highest level, injection of acid promoted syneresis, and residual moisture was observed inside cheese packages. Thus, after 5 injections the moisture content of cheese decreased from 34% to 31%. This resulted in decreased cheese weight, 2.5% after 5 injections. Injecting acid decreased cheese hardness, and at the highest levels of injection, decreased pH and moisture content caused the cheese to become brittle. Thus, the cheese lost structural cohesion, fracturing during testing. When heated, the initial rate of cheese flow increased when pH was lowered from 5.3 to 5.0. However, lowering cheese pH to 4.7 caused decreased flowing rate. Also, the final extent of cheese flow was unaffected by lowering pH to 5.0, but it decreased when cheese pH was lowered to 4.7. We concluded that adding an acid solution to cheese alters protein interactions. At low levels, acid injection decreases interactions between proteins as calcium is solubilized. In contrast, at

high levels, acid injection promotes protein-to-protein interactions as the proteins approach their isoelectric point. Hence, the acid precipitation of proteins overcomes the opposing effect caused by increased calcium solubilization. Therefore, calcium content would direct cheese functionality when the pH of cheese is above 5.0.

Key Words: Syneresis, Calcium, Acid precipitation

363 Impact of high solids cheesemilks that are standardized with cold ultrafiltration retentates on the functionality of non-pasta filata mozzarella cheese. S. Govindasamy-Lucey^{*1}, M. G. Zimbric¹, J. J. Jaeggi¹, M. E. Johnson¹, and J. A. Lucey², ¹*Center for Dairy Research, University of Wisconsin, Madison, Wisconsin, USA*, ²*Department of Food Science, University of Wisconsin, Madison, Wisconsin, USA*.

Non pasta-filata mozzarella (pizza) cheese, a washed, stirred curd style cheese made with mesophilic starter, was manufactured from a blend of cold (whole milk) UF retentate (28% TS) and partially skimmed milk to obtain a milk with 13.6% solids and a casein:fat ratio of 1.0. Control cheese was also made with partially skimmed milk (casein:fat ratio of 1.0, and 11.25% solids). Coagulation was monitored by dynamic low-amplitude oscillatory rheology (DLAOR) in a Physica UDS200 rheometer at 34°C. Cheese functionality was assessed using the UW-Meltmeter, DLAOR and by visual observation when baked on pizza. Gels made from the UF fortified cheesemilks coagulated faster (17 vs 25 min). Rate of firming was also considerably faster in UF fortified milks. The shear stress of the gels, force required to break gels, was considerable higher (50 vs 26 Pa) in the UF fortified cheesemilks compared to control samples. UF fortified cheeses had lower moisture contents (44.6-46.6%) than control cheeses (46.8-49.5%). Melting was assessed by the rate of decrease in cheese height measured by UW-Meltmeter and the rate of increase in the loss tangent parameter (at temperatures > 40°C) as determined from DLAOR tests. The storage modulus (G') of the cheese decreased with increasing temperature as the cheese was heated in the rheometer. The loss tangent curves were shifted higher as the cheeses aged. Melting properties at 1 wk were similar. At 2 wk, UF fortified cheeses melted faster than control. In cheeses ripened between 1 to 3 mo, differences in melting between cheeses were reduced. There were no significant differences in the functional performances between cheeses when they were baked on pizzas. Proteolysis levels, as indicated by TCA-soluble nitrogen, were similar in both cheeses. In conclusion, fortification of pizza cheesemilks with UF retentates at least up to 13.5% total solids had a relatively minor influence on cheese functionality but there was increased fat and nitrogen recoveries as well as reduced moisture contents.

Key Words: Ultrafiltration, Non pasta-filata mozzarella, Cheese rheology

364 Does presalting and brine concentration influence salt uptake by Ragusano cheese? C. Melilli^{*1}, D. M. Barbanò², G. Licitra³, G. Tumino¹, G. Farina¹, and S. Carpino¹, ¹*Consorzio Ricerca Filiere Lattiero Casearia, Ragusa, Italy*, ²*Northeast Dairy Food Research Center, Cornell University, Ithaca, NY*, ³*D.A.C.P.A, Catania University, 95100 Catania, Italy*.

Raw milk (864 L), was made into Ragusano cheese. Prior to stretching, the curd (pH=5.23 and 16C) was cut into slices and divided into 22 (11 presalted and 11 not presalted) portions of 3.9 kg. The 11 presalted cheeses were made by dry salting (2% w/w) the slices of curd prior to stretching. At the end of stretching each 3.9 kg mass of cheese was shaped (15x15x15 cm) and held for 22 h at 18C. One of the 11 presalted and one of the 11 non presalted cheeses were analyzed prior to brining. Five of the 10 presalted blocks and five of the 10 non presalted blocks were submerged in a saturated brine for 24 d. The 5 remaining blocks of presalted and the 5 of the non presalted cheeses were totally submerged in a brine containing 18% salt, for 8 d and then they were moved to the saturated brine until 24 d. Cheeses were removed from the brine at 1, 4, 8, 16 and 24 d, weighed and analyzed. The uptake of salt and the loss of moisture were measured by dividing the entire block of cheese in four portions representing the surface to the center. The cheeses kept in saturated brine for 24 d lost (P<0.01) more weight than cheeses that were in 18% brine for the first 8 d. The total salt content (g) was increased (P<0.01) by both presalting and use of 18% salt brine. Moisture loss was higher with presalting (P<0.05) and saturated brine (P=0.07). Salt (%) decreased and moisture (%) increased from the surface to the center of each block. Presalting had no detectable impact on moisture content

in any location within the block. The moisture (%) at the surface of the block in 18% brine was higher ($P < 0.01$) than for saturated brine. This produced a more open, soft structure at the surface of the blocks in 18% brine and allowed more uptake of salt. Subtracting the effect of the presalting treatment from the salt content shows clearly that the lower brine concentration had the strongest impact on increasing both the total salt (%) and rate of salt uptake.

Key Words: Brine, Presalting, Ragusano cheese

365 Temperature induced moisture migration in reduced fat Cheddar cheese. A.A. Olabi*¹ and D.M. Barbano¹, ¹Cornell University, Northeast Dairy Foods Research Center, Ithaca, NY.

Moisture migration during cooling of 290 kg Cheddar cheese blocks is a problem. The problem is of greater magnitude in reduced and low fat varieties. The objective of this study was to design and evaluate the performance of a laboratory scale apparatus for simulation of temperature induced moisture migration in 290 kg blocks of Cheddar cheese. Two apparatus were designed to produce a systematic temperature gradient in small cheese slabs over a 36 h period to simulate the temperature gradient that develops during cooling of a 290 kg block. One of the apparatus was designed to induce a moisture migration downwards with gravity and the other against gravity. The apparatus produced moisture migration ranges of 9.7% and 6.4%, for the apparatus to induce moisture migration downwards and upwards, respectively. The moisture moved from areas of warm cheese to areas of cold cheese during cooling, as occurs in 290 kg blocks. These ranges were comparable to the ones obtained with 290 kg reduced-fat Cheddar blocks. In addition, small but significant differences in pH were created within slabs. The direct effect of the temperature gradient on moisture migration within cheese slabs appeared to be more important than the possible impact of the small pH gradient produced within the cheese by the temperature gradient.

Key Words: Reduced Fat Cheddar, Moisture Migration, Temperature

366 Studies on using milk protein concentrate in pizza cheese manufactured by culture or direct acidification. Shakeel Rehman*¹ and Nana Farkye¹, ¹Dairy Products Technology Center, California Polytechnic State University, San Luis obispo, CA 93407.

Milk protein concentrate (MPC) has high casein, low lactose and high calcium content. Enrichment of cheese milk with MPC should, therefore, enhance yields and improve quality. The objectives of this study were: (1) to compare pizza cheese made by culture acidification using standardized whole milk (WM) plus skim milk (SM) vs WM plus MPC; and (2) Compare cheese made using WM + MPC by culture acidification to that made by direct acidification. The experimental design is as follows; vat1 (V1) = WM + SM + culture (commercial thermophilic lactic acid bacteria), vat 2 (V2) = WM + MPC + culture, and vat 3 (V3) = WM + MPC + direct acid (2% citric acid). Each cheese milk was standardized to a casein to fat ratio of 1.1. The experiment was repeated thrice. Yield and composition of cheeses were determined by standard methods while the proteolysis was assessed by urea polyacrylamide gel electrophoresis (PAGE) and water soluble N contents. Meltability of the cheeses was determined during one month of storage, in addition to pizza making. The addition of MPC improved the yields from 10.34% 0.566 in V1 cheese to 14.5% 0.844 and 16.65 2.23, respectively in V2 and V3 cheeses but the moisture (at 50%) adjusted yields were 10.74, 18.28 and 11.12 % for V1, V2 and V3 cheeses respectively. The % fat recoveries were 78.19 7.0, 86.29 13.02 and 77.07 6.40 in V1, V2 and V3 cheeses respectively. The % total solid recoveries were 45.72 4.97, 57.90 1 and 55.53 6.40 in V1, V2 and V3 cheeses, respectively. The % protein recoveries were 64.13 6.74, 61.52 % 11.84 and 58.44 14.04 in V1, V2 and V3 cheeses respectively. The % moisture, fat, protein and salt were 49.60 2.78, 20.16 1.60, 22.47 2.258 and 1.16 0.58; 46.22 2.24, 21.66 2.30, 23.08 0.49 and 2.22 0.36; 55.14 0.80, 16.0 1.73, 21.51 2.00 and 2.04 0.34, respectively in V1, V2 and V3 cheeses. The V1 cheese had better meltability than V2 cheese initially but the difference became minimum during storage. V3 cheese had best meltability. The lowest and highest levels of proteolysis were found in V2 and V3 cheeses. The study demonstrates use of MPC in pizza cheese manufacture with improved yield both by culture acidification as well as direct acidification.

Key Words: Pizza cheese, milk protein concentrate, yield

367 Effect of modifying lactose concentration in cheese curd on proteolysis and quality of Cheddar cheese. Shakeel Rehman¹ and Patric Fox², ¹Dairy Products Technology Center, Calpoly State University, San Luis Obispo, CA 93407, ²Department of Food Science, Food Technology and Nutrition, University College, Cork, Ireland.

The objectives of this study were to determine the role of lactose in Cheddar cheese. Cheese was manufactured from three 100 kg batches of milk: (1) control (C), (2) lactose-reduced cheese (L), in which a volume of whey equal to 40% of the original volume of milk was removed and replaced with 25% volume of water (40C) at the start of cooking, and (3) lactose enriched-cheese (H) was made from milk supplemented with lactose powder to give 8.4% lactose in cheese milk. Samples were taken during ripening for enumeration of starter bacteria, non-starter lactic acid bacteria (NSLAB), residual lactose (RL), pH and proteolysis. Proteolysis in the cheeses during ripening was assessed by determining water-soluble N (WSN) as % of total N, urea polyacrylamide gel electrophoresis (PAGE) of the water-soluble (WSF) and -insoluble fractions, reverse phase-HPLC of 70 % ethanol-soluble (ES) and insoluble (EIS) fractions of WSF, concentration of individual and total free amino acids (TFAA). During ripening the cheeses were graded by two commercial graders and by a 14-member sensory panel. The L-cheeses were depleted of lactose within 90 days of ripening while the H cheese contained 1.4 % RL up to 180 days of ripening. The pH remained constant in C and L cheeses, while it dropped continuously in the H cheeses during ripening. The modification of lactose caused no marked effect on gross composition, primary proteolysis or on numbers of starter bacteria and NSLAB in the cheeses. RP-HPLC showed that L cheese had the lowest concentration of ES peptides and highest concentration of EIS hydrophobic peptides. The lowest and the highest concentration of TFAA were in H and L cheese, respectively. Commercial graders perceived L cheese too young for grading up to 4 months of ripening but 180 day-old L cheese was awarded flavor scores similar to C cheese. The 180 day-old H cheese was awarded poorest flavour scores. Sensory evaluators reported that L cheese had a significantly lower flavor intensity and a less sour acid flavor, a lower firmness and was more crumbly but had better mouth-coating properties than the control or H cheese. The H cheese was more rubbery than the C or L cheese.

Key Words: Cheddar cheese, lactose, proteolysis

368 Regional differences in the chemical and microbial quality of Cheddar cheese manufactured in the United States. N.A. Khilla*¹, T. Considine¹, and N.Y. Farkye¹, ¹Dairy Products Technology Center, California Polytechnic State University, San Luis Obispo, CA.

The quality of Cheddar cheese is derived from the initial quality of milk and from added starter and nonstarter microflora that colonize cheese during manufacture and ripening. Variations in nonstarter lactic acid bacteria (NSLAB) may be plant specific, leading to suggestions that regional differences exist in Cheddar cheese quality. This study's objective was to determine if regional differences exist in the chemical and microbial quality of Cheddar cheese during ripening. Commercial Cheddar cheese manufactured in thirteen different factories across the U.S. were analyzed at Cal Poly, San Luis Obispo. Cheeses were aged for approximately 2 months in the respective factories of origin before receipt at Cal Poly, where they were ripened at 8C. Cheeses were sampled on the day of arrival (day 0) and at intervals of 1, 3, 6 and 9 mo (corresponding to actual cheese age of 3, 5, 7 and 11 mo) for analysis. Chemical (i.e., proteolysis) and microbial (i.e., counts for total bacteria, starter and NSLAB) analyses were performed. The levels of water soluble N (WSN) in day 0 samples ranged from 6.6 to 19.2%, and from 24.3 to 50.7% after 9 mo ripening. The rate of increase in WSN was apparent between cheeses from different factories. Concentrations of free amino acids (measured by the cadmium ninhydrin method) ranged from 0.19 to 2.85mg Leu/g at day 0 and from 2.92 to 8.87mg Leu/g after 9 mo. On day 0, starter counts ranged from 10^6 to 10^9 CFU/g while NSLAB counts ranged from 10^5 to 10^9 CFU/g. At 9 months starter counts were $< 10^5$ CFU/g while most of the NSLAB counts were 10^4 to 10^5 CFU/g. Over 124 random isolates grown on casein agar plates showed that approximately 44% hydrolyzed casein. Results suggest differences in ripening profile of Cheddar cheeses made in different factories.

Key Words: Cheddar, Proteolysis, Microbial

369 Determination of organic acids in the water soluble fraction of Cheddar cheese. Therese Considine*¹ and Nana Farkye¹, ¹Dairy Products Technology Center, Calpoly State University, San Luis Obispo, CA 93407.

The objective of this study was to compare the current method of analyzing organic acids in cheese with a modified method using the water soluble fraction (WSF) of cheese. Organic acids play an integral role in cheese quality as they are believed to contribute to the flavor. Depending on their concentrations, organic acids together with sulfur compounds, lactones, methyl ketones, alcohols and phenolic substances can have a negative or positive contribution to cheese flavor. Organic acids appear because of the hydrolysis of fatty acids, bacterial growth, normal bovine metabolic processes or direct addition of acidulants. Quantitative determination of organic acids in dairy products is important to monitor starter culture activity, bacterial growth and to trace quality changes

during ripening. Current methods of analyzing organic acids in cheese require lengthy extraction, whereby five grams of cheese is stirred for one hour in 25 ml dilute (0.009N) H₂SO₄, followed by centrifugation, filtration and Aminex HPX-87H[®] column with detection between 210-214 nm. In many cases of cheese research, especially when monitoring proteolysis, the WSF is already prepared for further research (e.g., for determination of free amino acids, water soluble nitrogen levels). Thus, by adjusting the WSF (50g cheese/100 ml water) with H₂SO₄ to give a final concentration of 0.009 N H₂SO₄, it is possible to monitor organic acids in the WSF. Six cheeses analyzed by both the current and modified WSF yielded almost identical HPLC profiles. The organic acids detected were: orotic, oxalic, pyruvic, propionic, lactic and uric acid. The simplicity of the method allows rapid monitoring of organic acids during ripening of cheese.

Key Words: Water soluble nitrogen, Cheese, Organic acids

**Forages and Pastures
Silages and Forage Composition**

370 Effect of alfalfa hay and silage on the performance of dairy cows in early lactation. A. A. Naserian*¹, ¹Ferdowsi university of Mashhad.

alfalfa hay is popular crop in dairy cattle feeding but it is not suitable for silage because of, low in soluble carbohydrates and high buffering capacities. Hay, untreated, and treated with 0.5%urea alfalfa silage were studied with nine multiparous Holstein cows. Weighting mean was 594±42Kg in this trail. The average milk production of the cows was 29.9 ±1.7 Kg/d prior to the experiment. Cows were randomly assigned to 3*3 latin square designed experiment. Diets were A)30% alfalfa hay +12%corn silage +5% cottonseed +53% concentrate B)30%untreated alfalfa silage with similar ingeridents in diet A C)30% treated alfalfa with 0.5% urea with similar ingerdents in diet A. The diets were balanced to supply requirements according to(NRC 1989)and were offered ad libitum in two equal portions. Each experimental period was 21 days. the cows were adapted to their diets for 14 days which was followed by a 7 days collection period for determination of digestibility and milk production. milk and blood samples were taken in the last two days of every collection period. The results indicated that intakes of dry matter were similar in different diets. No significant differences were detected for DM, OM, CP, NAF and ADF digestibilities. Milk production was slightly higher in treatment 3(31.28) versus 1(30.92).Blood metabolites were not affected by treatments expect blood urea nitrogen which was higher in treatment 3 (15.58) versus 1(12.07). Therefore it seems that alfalfa silage can be used up to 30% of rations DM without any advere effects on the milk production and compositions

for the three treatments, respectively. For the last 6-days, heifers fed silage protected with the starch-salt covering were fed 0.91 kg (as-fed) of the covering daily. Heifers consumed 91% of the covering. The ash content of the pre-ensiled forage and spoilage from uncovered, plastic, and starch-salt treatments averaged, 5.8, 11.4, 8.7, and 18.3%, (P <0.05) respectively. These data suggests that a portion of the salt leached into the silage immediately under the covering.

Key Words: Bunker Silo, Edible Covering, Spoilage

372 Effects of substituting sunflower silage for corn silage in diets for lactating cows. L. A. Leite¹, B. O. Silva¹, R. B. Reis*¹, L. M. Fonseca¹, and D. K. Combs², ¹Escola de Veterinária UFMG, Brasil, ²University of Wisconsin, Madison.

Objectives of this study were to compare dry matter intake, apparent dry matter digestibility, milk yield and milk composition of Holstein cows fed diets in which sunflower silage (SS) replaced corn silage (CS) as the forage component. Five ruminally- cannulated cows, 60 to 82 DIM, were arranged in a 5X5 Latin Square design. Periods were 21 days and treatments were dietary forage from: 100% corn silage (100CS); 34% sunflower silage plus 66% corn silage (34SS); 66% sunflower silage plus 34% corn silage (66SS); 100% sunflower silage (100SS); or 100% corn silage plus whole cotton seed (CS-WCS). The diets were formulated according NRC 2001, to be iso-nitrogenous and iso-energetic. Dry matter intake, milk yield and milk protein yield were lower for 100SS compared to 100CS (P<0.05). However, partial replacement of CS with SS did not affect milk and protein yield. Cows on diets with 34 or 66% of the forage as SS produced more milk per unit of dry matter intake compared to those on CS-WCS diet. Partial replacement of corn silage with sunflower silage could be a viable option for lactating cows in this range of milk production.

Key Words: Dairy cattle, Alfalfa silage, Milk production

371 Edible covering reduces spoilage in bunker silos. L.L. Berger*, N.A. Pyatt, and J.R. Sewell, University of Illinois-Urbana.

The goal of this research was to develop an edible covering for bunker silos that would simultaneously reduce spoilage and serve as a nutrient source when fed. The criteria used in developing the covering was that it must provide effective protection, be edible, provide essential nutrients, be palatable, cost effective, and easy to apply. Whole plant corn (40.0% DM) was chopped and packed to equal densities (215 kg DM/m³) into six side-by-side 3.66-m long x 1.83-m wide x 1.83-m deep bunker silos. Equal volumes (1570.5 kg DM) of pre-ensiled whole-plant corn were weighed into each bunker, leveled and packed with a small tractor and lawn roller. The three treatments were, uncovered, covered with polyethylene plastic, or covered with a starch-salt matrix. The starch-salt matrix was applied to achieve a surface thickness of 1.5 cm. After curing 3 days, paraffin wax was melted and a thin layer applied to the starch-salt matrix with a paint roller. The forage was ensiled for 92-days. Spoiled silage was separated prior to feeding. A wooden frame 148.6 x 30.5-cm was utilized to measure the spoilage under a fixed area. This measurement was made at 3 locations on each silo. Surface spoilage under the frame was 14.3, 16.4 and 1.2 kg DM (P < 0.05) for the uncovered, plastic and starch-salt coverings, respectively. Forty-eight Angus heifers were allotted by weight to 12 pens. Two pens of heifers were randomly assigned to each silo. Silage DM fed was 704, 887, and 1220 kg (P <0.05) for the uncovered, plastic and starch-salt covered silos, respectively. Animal days per bunker were 140, 152, and 212 (P <0.05)

	100CS	34CS	66CS	100SS	CS-WCS	SEM	P value
DMI, kg/d	21.3 ^a	19.7 ^{ab}	19.1 ^{ab}	17.6 ^b	20.3 ^a	1.39	0.02
DM Dig, %	69.2	64.6	63.9	57.8	68.1	6.34	0.10
Milk Yield, kg/d	27.4 ^a	27.5 ^a	27.3 ^a	24.0 ^b	25.5 ^{ab}	1.57	0.02
FCM, kg/d	26.2	25.0	25.2	22.6	25.5	1.93	0.10
Fat, %	3.7 ^{ab}	3.4 ^a	3.5 ^{ab}	3.6 ^{ab}	4.0 ^a	0.26	0.03
Protein, %	3.1 ^a	2.8 ^{ab}	2.7 ^b	2.9 ^{ab}	3.0 ^a	0.14	0.02
Fat Yield, kg/d	1.02	0.94	0.96	0.87	1.02	0.10	0.14
Protein Yield, kg/d	0.84 ^a	0.78 ^{ab}	0.74 ^{ab}	0.70 ^b	0.77 ^{ab}	0.06	0.04
MUN, %	0.229	0.233	0.240	0.237	0.226	0.02	0.87
Milk Yield, kg/kg DMI	1.29 ^{bc}	1.40 ^{ab}	1.46 ^a	1.39 ^{ab}	1.26 ^b	0.09	0.04

^{a,b,c} Means within the same row with different superscript differ according to the P value in the table.

Key Words: corn silage, sunflower silage, dairy