T66 An x-ray system to assess Ragusano PDO quality. G. Impoco[1], C. Pasta[1], G. Portelli[1], G. Marino[1], M. Caccamo*[1], S. Carpino[1], and G. Licitra1,2, [1]*CoRFiLaC, Regione Siciliana*, *Ragusa, Italy*, [2]*D.A.C.P.A., University of Catania*, *Catania, Italy*.

Accept/reject judgments in Ragusano Protected Designation of Origin (PDO) quality assessment are highly subjective due to the lack of standard evaluation protocols. Moreover, assessment takes place on aging centers. X-ray scanning is a mature technology used in the industrial chain to inspect the inner structure of food. The use of x-ray images of cheese blocks was investigated to judge cheese quality, the main reason being that this technique is non-destructive. Moreover, evaluating quality on a common ground would open the possibility of devising quantitative image analysis tools, inspired by objective evaluation protocols. An evaluation scale was created to objectively score cheese blocks by visual inspection of x-ray images. According to inspectors' suggestions, 7 relevant criteria were chosen. Six inspectors assessed these parameters on a few test images of Ragusano PDO and assigned a weight to each of them. Then, a 7-item on a 9-point semantic differential scale was created. A data set of 223 images manually evaluated cheese blocks was collected. From this data set, 64 images were randomly extracted. Images were evaluated using the scale Furthermore, inspectors also assessed cheese acceptability only based on images by using a yes/no criterion. Two weeks later, inspectors observed the same 64 images only to evaluate cheese block acceptability, with no scale use. Results of both experiments were compared with the on-field evaluation to determine whether the scale was useful for quality assessment. The scale presented a final reliability with both Cronbach's α test and standardized Cronbach's α of about 0.81. Construct validity assessed on all 7 items resulted in a 2-factor solution that explained 79.5% of the scale variance. By using the scale, cheese acceptability evaluated by images was consistent with on-field evaluation for 62% of cheese blocks, whereas without the scale consistency dropped down to 37%.

Key Words: quality evaluation, cheese, x-ray imaging

T67 Effects of rapid visco analyzer on the functional properties of imitation mozzarella cheese. S. He[1,2], X. Li*[1,2], Y. Ma[3], C. Yao[2], and B.Wu[1,2], [1]*Key Laboratory of Dairy Science, Northeast Agricultural University, Ministry of Education*, *Harbin, Heilongjiang, China*, [2]*College of Food Science, Northeast Agricultural University*, *Harbin, Heilongjiang, China*, [3]*School of Food Science and Engineering, Harbin Institute of Technology*, *Harbin, Heilongjiang, China*.

A small-scale manufacturing method of imitation cheese was developed by a rapid visco analyzer (RVA). In this work, imitation mozzarella cheeses with similar chemical compositions, made by RVA at a stirring speed of 200, 300 or 450 rpm and by the Stephan cooker at 1,500 rpm, were investigated through functional properties, microstructure and sensory evaluation. A color measurement instrument (model ZE-6000, Nippon Denshoku Industries CO., Ltd., Japan) revealed that the increase of stirring speed in RVA method made the color more white. Within the range of speeds in the present study, the relationship between the minimum apparent viscosity (y, cP) and speeds (x, rpm) was best described by a linear model y = 0.9x + 685.3 (r2 = 0.968). Through free-oil release analysis, the fat leakage of imitation cheese at 450 rpm was significantly higher than the others. On the Texture profile analysis (TPA), the hardness of imitation cheese significantly increased, and the adhesiveness sharply decreased while the springiness and cohesiveness values remained unchanged. However, there was not a significant effect on functional properties of imitation cheeses between RVA at 450 rpm and Stephan cooker at 1,500 rpm. The microstructure of imitation cheeses observed by scanning electron microscopy, showed that increasing stirring speed seemed to reduce the fat globules size and form a uniform protein matrix. In the sensory evaluation, the imitation cheese manufactured by RVA at 450 rpm was not a significant difference with the control made by the Stephan cooker. The RVA can be used as a small-scale manufacturing tool for making the imitation cheeses with similar functional properties.

Key Words: imitation mozzarella cheeses, rapid visco analyzer (RVA), functional properties

T68 A sensor technology for monitoring and controlling syneresis in the cheese vat. T. G. Ferreira*[1], M. Castillo`, F. A. Payne[1], C. O'Donnell[3], and D. O'Callaghan[4], [1]*University of Kentucky*, *Lexington*, [2]*Universitat Autònoma de Barcelona*, *Spain*, [3]*University College Dublin*, *Ireland*, [4]*Moorepark Food Research Center, Teagasc, Fermoy, Co. Cork, Ireland*.

Cheese quality is affected by curd moisture content which is determined during the whey syneresis step. The syneresis step in cheese processing is currently controlled empirically by the processor as there are no on-line sensor technologies available for monitoring curd syneresis. A novel non-destructive optical sensor technology that is able to monitor both milk coagulation and curd syneresis in a stirred cheese vat has been developed. The objective of this study was to evaluate the performance of the sensor technology over a wide range of coagulation and syneresis rates. A 5-factor, fully randomized, fractional, factorial central composite design (CCD) was employed. The 5 experimental factors selected were milk coagulation temperature, milk pH, fat to protein ratio, calcium chloride addition level, and gel cutting time. The CCD consisted of a 2k-1 factorial (k = 5) with 2k axial points and 7 center points (33 runs). A homogeneous sample of curd and whey was removed from the cheese vat from 5 until 85 min after cutting on 10 min intervals. Fat, protein and total solids content of whey, curd, and milk were determined. Also, the weight of curd and whey produced was expressed as a percentage of the initial weight of milk to provide the actual curd and whey yield. A curd aliquot was pressed for determination of pressed cheese moisture content. Results confirmed previously observations for both curd moisture content and light backscatter ratio changes during curd syneresis. The largest change in curd moisture content was observed during the first 15–30 min of syneresis. However, significant moisture content changes were observed in pressed cheese samples at all different post-cutting times. These results clearly suggest an important role of syneresis end point selection on moisture content consistency of fresh, pressed cheeses. Successful validation and of the syneresis sensor technology scale up and subsequent transference to the industry will have a large impact on cheese production efficiency and cheese yield. Not only will the sensor have industrial applications, it could also serve as a powerful tool for research.

Key Words: on line sensor, syneresis, moisture content control

T69 Method to quantify retention of lipid soluble substances in a cheese curd model system. M. Tippetts* and S. Martini, *Utah State University*, *Logan*.

The purpose of this study was to find a way to quantify how much of an emulsion′s lipid soluble substances are retained in a cheese curd model

system by image analysis rather than alternate methods such as HPLC. Soybean oil (SBO) was the oil phase and it was saturated with Nile red, which is an indicator for liposoluble substances. The oil-in-water emulsion was made using a 1 wt % protein non-fat dairy powder aqueous solution, and a 5 wt% oil phase. The saturated Nile red SBO was added to the system as 0, 20, 40, 60, 80, and 100% of the total SBO. Each emulsion was homogenized using a microfluidizer. After emulsion formation 5 mL of the emulsion were pipetted into pre-heated 3.36 wt% protein milk protein concentrate solution. The ratio of emulsion to milk solution was 1:40. Curd was made and then samples were taken of each sample, placed in a mold and under UV light images were taken using an ethium bromide filter, which excited the Nile Red in the curd. The images were then analyzed using ImageJ software′s macro for RGB histogram. The intensities of red (histogram) for the mean and mode were plotted with respect to the concentration of Nile red. Data was fitted using linear regression with R2 values of 0.994 (mean) and 0.996 (mode). The correlation found for each measurement is: $y = 0.379x + 7.361$ and $y = 0.392x + 5.385$ for the mean and mode, respectively. These results show that a good linear correlation exists between the amount of Nile red added to the emulsion and the final red intensity found in the curd. Correlations found with the mode measurements seem to be more sensitive to changes in Nile red concentration due to the slightly steeper slope obtained in the linear correlation. Since Nile red is a lipid-soluble compound, this technique can be used to quantify the amount of lipid soluble substances retained in a model system for cheese curd.

Key Words: lipids, emulsion, cheese

T70 Effect of storage at ambient temperature on calcium lactate crystallization in Cheddar cheese. F. Su, P. Rajbhandari, and P. Kindstedt*, *University of Vermont*, *Burlington*.

Supermarkets sometimes hold cheese at ambient temperature in unrefrigerated aisle displays to enhance sales. Storage temperature is an important risk factor in calcium lactate crystal formation, but the effect of ambient storage followed by refrigerated storage has not been reported. In this study, Cheddar cheese was made at the University pilot plant and aged for 3 mo at 5°C. The cheese block (9 kg) was then sectioned into retail-sized (ca. 14.5 × 4.5 × 4.5 cm; 350 g) chunks and 9 chunks were randomly chosen for study. For each of the 9 samples, one of the large (ca 14.4 × 4.5 cm) surfaces was from the exterior of the 9 kg block and thus relatively rough due to curd granule junctions and press cloth indentations; the opposite surface was cut smooth with a wire cutting device. The samples were vacuum packed at 50 mbar and randomly assigned to 3 temperature treatments. Two sets of 3 samples were held at 20°C for either 24 or 48 h, respectively, before being stored at 1°C. A third set was immediately stored at 1°C, which served as the control. Digital photos of rough and smooth surfaces were taken triweekly for 28 wk and the number and area of crystal regions were determined by image analysis. Data were analyzed by repeated measures ANOVA. The number and area of crystal regions were significantly affected by surface roughness, storage temperature and storage time. Rough surfaces crystallized more profusely than smooth surfaces, and ambient storage for 24 or 48 h caused substantial reductions in crystal formation rates relative to control cheeses. The results indicate that short-term ambient storage rendered cheese surfaces less susceptible to crystallization, especially the rough surfaces that were heavily predisposed to crystallization. The mechanism for this effect is unclear but may involve temperature-induced alteration of the cheese surface and potential nucleation sites.

Key Words: Cheddar cheese, calcium lactate, storage temperature

T71 Effect of addition of calcium chloride and sodium chloride on aflatoxin M1 content during Egyptian Domiatti cheese processing. M. M. Motawee*[1], K. Genedy[1], and T. A. Nassib[2], [1]*National Organization for Drug Control and Research*, *Giza, Cairo, Egypt*, [2]*Faculty of Agriculture, Mansoura University, Mansoura, Egypt*.

Aflatoxins are highly toxic, mutagenic and carcinogenic compounds producing by some common molds as *Aspergillus flavus* and *Aspergillus parasiticus* during their growth on feedstuffs. Domiatti cheese is the most popular soft white pickled cheese in Egypt and makes up about of the 75% of the cheese produced and consumed in our country. The proportion of salt (5 to 14%) depends on the season of manufacture and on the temperature of cheese ripening. The present study was aimed to analyze the level of aflatoxin M1 (AFM1) by thin layer chromatography method in pasteurized milk, curd and whey after spiked milk with (AFM1) during Domiatti cheese processing. The results indicated that, the addition of $CaCl_2$ at the different concentration (0.01, 0.02, 0.03, 0.04 and 0.05%) had slight significant effect of AFM1 content in pasteurized milk. AFM1 content decreased from 1.4 ppb to 1.26 ppb with the addition of 0.01 and 0.05% of $CaCl_2$, respectively. While AFM1 content in curd was significantly ($P < 0.5$) increased from 6.7 to 7.5 ppb with the addition of 0.01 and 0.05 of $CaCl_2$ respectively. The increase of $CaCl_2$ concentration was accompanied with decrease of AFM1 content in whey of cheese. On the other hands, the addition of different concentration of NaCl (6, 8, 10 and 12% caused slight decreased of AFM1 in pasteurized milk from 1.38 ppb at 6% of NaCl to 1.26 ppb at 12% NaCl. Opposed results was showed in the curd, where AFM1 decreased from 6.7 ppb at 6% NaCl to 6.1 ppb at 12% NaCl. The same trend was observed in whey.

Key Words: aflatoxin M1, NaCl, $CaCl_2$, Domiatti cheese

T72 Effect of milk fat content on goat cheese proteolysis elaborated with the traditional method. D. Sánchez-Macías*, I. Moreno-Indias, L. E. Hernández-Castellano, A. Morales-delaNuez, A. Torres, M. D. Ruiz-Díaz, A. Argüello, and N. Castro, *Department of Animal Science, Las Palmas de Gran Canaria University*, *Arucas, Las Palmas, España*.

Three different milk fat contents (5%, 1.5% and 0.4%) were used to manufacture full-fat cheese (FFC), reduced-fat cheese (RFC) and low-fat cheese (LFC) goat raw milk cheese according to traditional hand-made cheese practices in Canary Islands (Spain). Cheeses were ripened for 1, 7, 14 and 28 d. Water-soluble proteins were extracted at 1, 7, 14 and 28 d of ripening and they were separated on SDS-PAGE gel. The SAS PROC MIXED procedure for repeated measurements was used to evaluate the effect of differing fat content and ripening time on the proteolysis. Tukey's test was used to evaluate the differences between groups. β-casein was the greatest proportion in all type of cheese and at all ripening time. α_{s2}-casein and α_{s1}-casein were the most abundant after β-casein. Quantitative analysis showed a general reduction in each casein as ripening progressed. In the 3 types of cheese, the degradative rates of intact caseins was higher throughout the period of ripening in the α_{s1}-casein (60–70%), followed by β-casein (38–45%) and then by α_{s2}-casein (25–40%) than d 1 of ripening. Furthermore, the rate of degradation during the experimental time was lower as the fat content decreased. At d 28, the percentage of total principal caseins remaining was 62, 66.5 and 70% in FFC, RFC and LFC, respectively. The remaining α_{s2}-casein and α_{s1}-casein in FFC and RFC were lower than in LFC. In contrast, β-casein also showed degradation along the ripening, differences in degradation between the 3 types of cheese were not significant at 28 d. α_{s1}-casein was degraded faster and cheese contained 28–40% at 28 d of ripening. α_{s2}-casein was degraded slower in LFC

than in FFC and RFC. The electrophoretic bands of degradation products increased with the ripening time in all cheeses. The appearance of these fragments was higher in FFC than RFC and LFC. This statement is correlated to previous information, that the degradation rate of caseins was increased as cheese was fatter resulting in a greater appearance of degradation bands in FFC.

Key Words: cheese, low-fat, proteolysis

T73 Impact of salt substitutes on the sensory characteristics of reduced sodium process cheese. A. Kommineni*, J. Amamcharla, and L. E. Metzger, *Midwest Dairy Foods Research Center, South Dakota State University*.

Process cheese (PC) is an integral part of the American diet. However, consumption of PC is limited by its high sodium content (typically 1265 to 1596 mg/100g). A high dietary intake of sodium has been associated with hypertension. The major ingredient sources of sodium in PC are sodium based emulsifying salts, sodium chloride (NaCl) and natural cheese, contributing 38%, 39%, and 20% of the total sodium, respectively. As per the Code of Federal Regulations (CFR) the sodium content should be less than 950 to 1100mg/100g to be labeled as "reduced sodium" PC. One of the challenges in formulating an acceptable sensory quality reduced sodium PC is the elimination of bitter-metallic flavor that is typically associated with the potassium based salt substitutes. The objective of this study was to determine if new commercially available salt substitutes improve the flavor and acceptability of reduced sodium PC. Newly available salt substitutes (SOLO, NeutralFres, Modified potassium chloride (Nu-Tek: 14500 and Nu-Tek: 14510), potassium chloride) were utilized in the formulations. Metallic blockers and salt flavor enhancers were also incorporated in the formulation either in combination or alone along with salt substitutes to evaluate their ability to mask off-flavors. Potassium citrate was used as emulsifying salt in all the formulations. A triangle test was used to determine if there was any detectable difference in any sensory characteristic between control PC (1540 mg Na/100g) and reduced sodium PC. The reduced fat reduced sodium (RFRS) formulation containing NuTek-14510 and sodium gluconate was not significantly ($P < 0.05$) different from control PC. Similarly, low-fat- reduced-sodium (LFRS) formulation containing NuTek-14510, xylitol, and sodium gluconate was not significantly ($P < 0.05$) different from the control PC. The sodium content of the acceptable RFRS and LFRS were 700 and 710 mg/100g. In conclusion, Nu-Tek:14510 and sodium gluconate can be used to improve the flavor of reduced sodium PC.

Key Words: process cheese, sodium, salt substitutes

T74 Comparison of identified flavor compounds, texture and sensory properties in regular cream cheese and cream cheese made from whole milk powder. S. S. Jeon*, C. H. Chung, and H. S. Kwak, *Sejong University*, *Seoul, South Korea*.

This study was carried out to compare identified flavor compounds, texture and sensory analysis in regular cream cheese and cream cheese made from whole milk powder which were stored at 7°C for 4 weeks. To identify the flavor compounds, the cheeses were extracted and analyzed by solid phase microextraction (SPME) and gas chromatography-mass spectrometry (GC-MS), respectively. Tentatively identified flavor compounds were mainly 13 from acids, however, octadec-9-enoic acid and Z-11-tetradecenoic acid was not present. Z-7-tetradecenoic acid was produced only from the cheese made with whole milk powder. Two ketones, 1 amine, 1 alcohol and 2 alkene were produced from both cheeses, but 6-heptyltetrahydro-2H-pyran-2-one as lactone and 2,6,10,15,19,23-hexamethyl-,(all-E)-2,6,10,14,18,22-tetracosahexaene as alkene were produced only from cream cheese made from whole milk powder. Also 1 imide and 1 alkane were showed only from the sample cheese. The identified flavor components from the whole milk powder-made cheese were different from regular cream cheese due to heat treatment. However, in rheological properties, hardness, adhesiveness, cohesiveness, springiness and gumminess were not significantly ($P < 0.05$) different between control and sample. In sensory analysis, appearance, flavor, taste and texture properties were not significantly ($P < 0.05$) different between control and sample cheese. In addition overall acceptability in the cream cheese made from whole milk powder was similar to that in control. On the basis of our results, we conclude that the cream cheese made from whole milk powder showed almost no adverse changes in texture and sensory characteristics except few identified flavor components.

Key Words: cream cheese, whole milk powder, flavor, texture, sensory evaluation

T75 Identification of neutral volatile compounds, texture and sensory properties in cholesterol-removed cream cheese. S. S. Jeon*, S. J. Lee, and H. S. Kwak, *Sejong University*, *Seoul, South Korea*.

This study was carried out to identify neutral volatile compounds, and examine texture and sensory evaluation in cholesterol-removed cream cheese which was treated by closslinked β-cyclodextrin and stored at 7°C for 4 weeks. To identify the volatile compounds, the 4 week-stored cream cheeses were extracted and analyzed by solid-phase microextraction (SPME) and gas chromatography-mass spectrometry (GC-MS), respectively. Tentatively identified neutral volatile compounds were detected 12 acids, 2 ketones, 1 amine, 1 alcohol, 1 lactone and 1 alkene. The main components were acids, such as hexanoic acid, n-hexadecanoic acid, tridecanoic acid, octanoic acid, octadec-9-enoic acid, 9,12-octadecadienoic acid, n-decanoic acid, benzoic acid, dodecanoic acid, tetradecanoic acid, z-11-tetradecenoic acid and oleic acid. Other components were 2-tridecanone and 2-pentadecanone as ketones, 5-(p-aminophenyl)-4-(o-tolyl)-2-thiazolamine as amine, 4,6-di(1,1-dimethylethyl)-2-methyl phenol as alcohol, tetrahydro-6-pentyl-2H-pyran-2-one as lactone and 3,7,11,15-tetramethyl 2-hexadecene as alkene. The identified components from cholesterol-removed cream cheese were same as those from regular cream cheese. In rheological properties, hardness, adhesiveness, cohesiveness, springiness, gumminess and chewiness were not significantly ($P < 0.05$) different between control and cholesterol-removed cheese during storage at 7°C for 4weeks. In sensory analysis, appearance, flavor, taste and texture properties were also not significantly ($P < 0.05$) different between control and 4week storage periods. In addition, overall acceptability in the cholesterol-removed cheese was closely similar to that in control. On the basis of our results, we conclude that the cholesterol-removed cream cheese showed no adverse changes in flavor, texture and sensory characteristics.

Key Words: cream cheese, cholesterol removal, identification of flavor, sensory analysis

T76 Changes of Ragusano cheese aroma due to different levels of pasture intake. S. Carpino*[1], T. Rapisarda[1], I. Schadt[1], C. Pasta[1], G. Belvedere[1], and G. Licitra[1,2], [1]*CoRFiLaC, Regione Siciliana*, *Ragusa, Italy*, [2]*D.A.C.P.A. Catania University*, *Catania, Italy*.

In the Hyblean region of Sicily, 3 groups of 15 Holstein cows have been selected in one dairy farm, during the pasture season. At the beginning of the experiment, milk production and fat content were not different between groups, averaging 26.1 ± 8.1 (kg/cow/day) and 4.0

± 0.6 (%), respectively. The control group (CNT) was exclusively fed a total mixed ration. The remaining groups had additionally pasture access, either for 6 h (LP) or for 16 h (HP). After a 2 weeks adaption period, milk of each group was collected separately, 4 times with a 15 d interval, and 2 Ragusano cheeses were produced. In total, 24 forms were made: 12 aged at 4 (4M) and 12 at 7 (7M) months. The aim of the study was to evaluate the effect of different levels of pasture intake on Ragusano cheeses aroma. Differences in volatile compounds were detected and analyzed by Smart Nose system (LDZ, Switzerland) with principal component analysis (PCA). Odor active compounds were also analyzed by gas chromatography–olfactometry extracted by both, steam distillation and headspace solid-phase microextraction. Odor active compounds were classified into "good" (G): flower, fresh, fruit, green, honey, nut, milk, butter, sweet, vanilla; "bad" (B): animal, broth, burnt, plastic, fried, potato, garlic, onion, rancid, and "not good, not bad" (N): hay, soil, mushroom, pungent, spicy. Differences between compound frequencies were evaluated using the Tukey's HSD test. Mean pasture intakes and standard deviation, relative to total dry matter intake, were 30.6 ± 6.9% in the LP group, and 68.1 ± 2.7% in the HP group. In both, 4M and 7M cheeses, CNT, LP and HP samples were clearly separated by PCA analysis, indicating differences in volatile composition. Feeding differences had no effect on the numbers of N or B odour active compounds, neither in the 4M nor the 7M cheeses. In the 4M cheeses, but not in the 7M cheeses, "good" compounds were more frequent when milk derived from the LP or HP compared with CNT ($\alpha = 0.05$; Q = 3.72). Pasture nutrition of cows might have less importance for aroma quality of 7M compared with 4M aged cheeses.

Key Words: Ragusano cheese, pasture, aroma compounds

T77 Enzyme accelerated ripening of Turkish Mihalic hard cheese: proteolysis and lipolysis. T. Ozcan* and E. Kurdal, *Uludag University, Department of Food Engineering*, *Bursa, Turkey*.

Mihalic cheese, a traditional Turkish hard cheese variety, is mostly produced around Bursa and Balikesir, and also known as Maglic, Mahlic or Kelle cheese. It is white with roundish holes, hard and crusty and made from high-fat sheep or cow milk. Ripening of hard cheese varieties is a slow and consequently an expensive process. During manufacturing and ripening proteolysis, glycolysis and lipolysis reactions, mainly driven by accelerating agents such as starter culture or enzymes, determine the sensory, chemical and textural properties of the cheese. The objective of the present work was to observe the effect of fungal lipase (Piccantase A from *Mucor miehei*), and a bacterial neutral protease from *Bacillus subtilis* (Fermizyme B500) alone or combined with a starter culture on the acceleration of the ripening process of Mihalic cheese made from cow's milk. Cheeses were analyzed at 2, 15, 30, 60 and 90 days of ripening. Casein fractions of Mihalic cheese samples were analyzed by urea polyacrylamide gel electrophoresis (PAGE) and lipolysis rates were measured as acid degree value (ADV). The proteolysis and lipolysis rate of Mihalic cheese samples displayed significant differences due to treatment and ripening period ($P < 0.01$). The highest lipolysis rate was noted monitored in lipase added cheese (as 5.56 ADV) with highest γ-casein ratio and β-casein degradation. Breakdown of casein was higher in starter + protease + lipase added cheese. At the end of ripening period, it was observed that α_s-casein ratios decreased in starter added, starter + protease added and protease added cheeses. Breakdown of β-casein continued throughout ripening, and there was an increase at the end of ripening regarding the ratios of other fractions. In view of sensorial acceptance, protease added cheeses having bitterness and crumbly textural properties due to intense breakdown of β-casein scored lower than lipase added samples.

Key Words: Mihalic cheese, proteolysis, lipolysis

T78 Seasonal variation in milk composition affects textural properties of low-moisture part-skim Mozzarella cheese. V. Jai*, U. Lund, and N. Farkye, *California Polytechnic State University*, *San Luis Obispo*.

The chemical composition of milk (specifically casein, fat and calcium contents) affects quality and functional properties of Mozzarella cheese. The objective of this study was to determine the effects of seasonal variation of milk components on texture properties of low-moisture part-skim (LMPS) Mozzarella in California. Concentrations of protein fractions (i.e., total protein (TP), true protein (TrP) and casein), fat, Ca, total solids (TS) and pH were measured in silo milk samples collected weekly over 15 mo from a dairy plant. LMPS mozzarella from the same plant was also collected biweekly during the same period. Seven days post manufacture the cheeses were analyzed for TP, fat, TS, total Ca, Ca in cheese filtrate, pH and texture properties e.g., hardness (g), cohesiveness, springiness, aggregation index (AGI) and % loss during shredding. Significant seasonal variation of casein, TP, Ca in milk were explained using a linear regression model equivalent to a basic single cosinor model with sine and cosine of week (converted into radians) as predictors ($y = \beta o + \beta 1 \cos(\text{time}) + \beta 2 \sin(\text{time}) + \varepsilon$) with *P*-values <0.05 and R-sq values >0.6. TP in cheese correlated positively with TP, TrP and casein in milk (Pearson correlation coefficient $r > 0.6$; $P < 0.001$). Ca in milk correlated positively with total Ca in cheese and cheese filtrate ($r > 0.4$; $P < 0.05$). Positive linear correlation between hardness, springiness and TP, casein in milk and cheese ($r > 0.3$; $P < 0.05$) were significant. Protein fractions and Ca in milk; TP and total Ca in cheese correlated negatively with the loss in shredding ($r < -0.5$; $P < 0.05$). The protein fractions in milk and cheese negatively correlated with AGI in cheese ($r < -0.45$; $P < 0.05$). Total Ca in cheese and milk correlated positively with springiness of cheese ($r > 0.4$; $P < 0.05$). Results show that concentrations of Ca and protein fractions in cheese milk significantly effect the texture and composition of LMPS mozzarella.

Key Words: low-moisture part-skim Mozzarella, seasonal variation of milk, textural properties

T79 A study of bioactive peptides in US Cheddar cheeses of different ages. Y. Lu*, S. Govindasamy-Lucey, and J. A. Lucey, *University of Wisconsin-Madison*, *Madison*.

Bioactive peptides (BP) have been found in fermented dairy products with various bioactive properties, such as, antihypertensive, angiotensin-I-converting-enzyme (ACE)-inhibitory, immunomodulatory, antimicrobial, mineral transport and opioid activities. The objective of this study was to determine the types and levels of BP produced during ripening of Cheddar cheese. Water-soluble extracts were prepared from Cheddar cheeses. Centrifugation and ultra-filtration were used to remove fat and to fractionate water-soluble extract into 2 fractions with molecular weight (MW) between 1000 to 3000 Da and MW ≤1000 Da, respectively. The fractions were subjected to HPLC -tandem mass spectrometry to identify peptides. HPLC - electrospray ionization (ESI) - time-of-flight (TOF) mass spectrometry was also used to identify peptides present in the fraction of MW ≤1000 Da. BP were identified by comparison with already published milk protein derived BP. A range of Cheddar cheeses of various ages was studied to identify the specific types and determine the levels of BP produced during ripening. In young (~6 d old) and mature (2 years old) Cheddar cheese, 8 and 34 ACE-inhibitory peptides, and 77 and 157 casein phosphopeptides, respectively, were found. With age more potent forms of ACE-inhibitory peptides were found. For some of the ACE-inhibitory peptides (including dipeptides, tripeptides, tetrapeptides and pentapeptides that had high ACE-inhibitory activity or low

IC_{50} values), the content appeared to increase with age as indicated by HPLC-ESI-TOF. Confirmation of the type and quantification of levels of BP in a range of different aged commercial Cheddar cheese is ongoing. Aged Cheddar cheese could be a good source of BP.

Key Words: bioactive peptide, angiotensin-I-converting-enzyme, mass spectrometry

T80 Effect of curd milling on the characteristics of Queso Fresco during storage. D. L. Van Hekken*[1], M. H. Tunick[1], N. Y. Farkye[2], J. B. Luchanski[1], S. Mukhopadhyay[1], and P. M. Tomasula[1], [1]*USDA, Agricultural Research Service*, *Wyndmoor, PA,* [2]*California Polytechnic State University*, *San Luis Obispo*.

Queso Fresco (QF) is one of the most popular fresh Hispanic-style cheeses in the US Manufacture of QF varies from country to country with many practicing fine milling of the curd before forming the cheese block. This study was undertaken to determine the effect of milling of the curd with different sized blades on the chemical, functional, and rheological properties of QF. QF was prepared from pasteurized, homogenized milk containing 0.1% of added $CaCl_2$. It was coagulated with chymosin and the curd was cooked at 39°C for 30 min and wet salted at 12.5% salt (wt salt/wt cheesemilk). Portions of the curds were then finely milled using different-sized meat grinder blades and hand-packed into molds for storage overnight at 4°C. Cheeses were removed from the molds the next day, sliced into smaller blocks, vacuum packaged, and stored at 4°C for up to 8 wks. Fresh QF contained 56.5 to 58.0% moisture, 22.2% fat, 15.7 to 17.6% protein, 2.5% lactose, and 2.4% salt. Moisture content decreased with aging ($P \leq 0.05$) because of wheying off; control QF (not milled or passed through grinder without blade) had the highest amount of wheying off (3%), while the finest milled QF had the lowest amount of wheying off (0.5%). All other properties were not affected significantly ($P \geq 0.05$) by the milling treatment or by storage for up to 8 weeks at 4°C. In QF, the homogenization step, know to alter milk protein-protein interactions, was sufficient to disrupt the cheese matrix and resulted in a crumbly cheese. The fine milling step did reduce the amount of whey lost from the cheese during storage but did not affect other functional or rheological properties of the QF.

Key Words: Queso Fresco, milling, wheying-off

T81 Pigments from nonthermal browning formed in Gouda and Parmesan cheeses. A. Lopez-Hernandez*[1], L. E. Rodriguez-Saona[2], M. M. Giusti[2], M. E. Johnson[3], D. A. Sommer[3], and S. A. Rankin[1], [1]*University of Wisconsin-Madison*, *Madison,* [2]*The Ohio State University*, *Columbus,* [3]*Wisconsin Center for Dairy Research*, *Madison*.

Under certain conditions, some cheeses develop a brown discoloration during the course of aging thus yielding changes in flavor and color. Parmesan and Gouda cheeses are some typical examples of the products where excessive browning and the concomitant caramel-like flavor have been noted. To date, very little definitive science exists to describe, define or control the reaction chemistry of non-thermal browning (NTB) in cheese from either the flavor or pigmentation perspective. Factors such as redox potential, available oxygen, the type and concentration of α-dicarbonyls, amino acid type and concentration, the presence of Mn^{2+} ions, and microbial tyrosinase activity are some of the suggested pathways proposed to explain the development of NTB. In the present work, the brown pigments from several Parmesan and Gouda cheese samples exhibiting various degrees of discoloration were extracted using methyl tert-butyl ether (MTBE) and further separated from the fat fraction by TLC. The L*, a* and b* values for the different samples were measured and ranged from 89.5 to 91.07, −0.923 to −2.14, and 1.14 to 3.99, respectively. The UV-Visible spectra of the colored compounds in the isolated fractions were characterized by the presence of unique absorption bands at 425, 451 and 472 nm. Attenuated total reflectance Infrared analyses (ATR-FT-IR) of the brown pigments revealed the presence of characteristic bands at 1103 and 1037 cm-1. These results suggest that the pigments may be comprised of lipid-containing moieties since those bands are very characteristic of in-plane C−H bending vibrations.

Key Words: browning, FT-IR, cheese pigments

T82 Whey ricotta: A scientific reevaluation. J. W.-M. Heick*, R. Jimenez-Flores, and H. Khalil, *California Polytechnic University*, *San Luis Obispo*.

Ricotta cheese is one of the first attempts in the dairy industry to utilize the whey left over during the manufacturing of chesses. Currently, ricotta is exclusively made from whole or skim milk and has a low commercial value. However, whey ricotta as made following the classic style (as described by Kosikowski) has great modern potential because it utilizes the by-product of cheese manufacturing (sweet or acid whey) and has an excellent nutritional profile and organoleptic properties. Our research focused on manufacturing high protein ricotta from whey while retaining the desired sensory and nutritional profile. An Italian style low acid cheese was manufactured at the Cal Poly Creamery, and the whey was collected after cutting at a pH of 6.60. The whey was then skimmed and/or ultrafiltrated before it was added to the steam kettle for processing. Three treatments were applied to the whey: fat skimming, ultra filtration and acidification, and the final ricotta was either pressed or left to drain naturally. Whey and ricotta samples were analyzed qualitatively and quantitatively for total protein before and after protein precipitation. Total protein was measured using the MilkoScan FT2 from FOSS, and the protein profiles were determined using sodium dodecyl sulfate PAGE (SDS- PAGE). Compositional analysis of the finished ricotta was conducted using the Babcock method for percent fat, Elementar rapid-n cube for protein, and CEM LabWave 9000 for moisture. The ricotta curd was analyzed along with the pre/post whey: skimming the whey resulted in a 80% drop in final fat content while ultrafiltration resulted in a increase in the effectiveness of protein removal from the post whey. Moisture levels were dependent on the whey treatments: 70–80% in non-pressed ricotta and 65–78% in pressed ricotta, protein content also varied with a range of 9–14%. Acidification occurred at 2 levels, high pH target of 5.5 resulted in the most neutral flavor while low pH 4.5 had more complete protein precipitation. The results highlight a practical methodology to manufacture a high quality whey cheese from by-product using equipment that is readily available to small cheese makers.

Key Words: whey, ultrafiltration, ricotta