

are designed to build experience for future careers and to create network contacts for future opportunities. Ideas and projects are developed in groups to build communication and interpersonal skills, helpful in a future work environment. Guest speakers provide business and industry perspectives on leadership and communications topics. A survey of ALA students indicated job shadowing was the most beneficial activity of ALA and students agreed they were able to demonstrate leadership

within their classes and student organizations. The partnership of faculty from different departments, business and industry professionals, and students in ALA provides a unique opportunity for Animal Science students to be prepared for leadership positions.

**Key Words:** Undergraduate, Leadership, Education

## Dairy Foods: Chemistry

**T270 Storage stability of lutein in cheddar cheese.** S. T. Jones\*, K. J. Aryana, and J. N. Losso, *Louisiana State University, Baton Rouge.*

The etiology of age-related macular degeneration (AMD) is complex; however, risk factors include genetic and environmental stimulus. As standard therapies for macular degeneration are limited, costly, and often associated with undesirable pathological side effects, the role of nutrition in protecting against AMD is intensively under scientific consideration. Lutein (3,3-dihydroxy- $\alpha$ -carotene) has been identified as a dietary strategy that can delay the onset of AMD. However, available food sources of lutein contain small amounts of lutein. Food fortification with lutein extract has been identified as a low budget prescription to prevent the onset and/or progression of AMD. The objectives of this study were to 1) incorporate various amounts of lutein into cheddar cheese; 2) analyze the stability of lutein during the cheese aging process; and 3) examine the color, pH, and microbiological profile of the cheddar cheese during storage. Lutein, extracted from corn was added to cheddar cheese in quantities of 1 mg, 3 mg, and 6 mg. Measurements of the lutein stability were carried out by HPLC using a YMC C<sub>30</sub> carotenoids column. Microbiological analyses of cheese samples included counts using SPC, Coliform, and Y/M Petrifilm. The attributes studied on the cheese were color and pH. The color attribute a\* ( $p < 0.05$ ) was significantly different among the treatment and control groups; however no significant difference were observed in L\*, b\*, and pH values. A significant difference ( $p < 0.05$ ) among 1 mg, 3 mg, and 6 mg treatments were observed in the SPC with respect to the control. The cheese samples were found not to have any coliforms ( $< 10$  cfu/g) and Y/M ( $< 10$  cfu/g). HPLC data showed quantitative recovery of lutein during the storage period and no lutein degradation products were identified. These results indicate that lutein, a functional food with purported ability to prevent or reduce the onset of macular degeneration; can be added to cheese as a value-added product.

**Key Words:** Lutein, Cheese, Age-Related Macular Degeneration

**T271 Physical properties of  $\kappa$ -casein stabilized emulsions.** R. Richter, P. Ungkuraphinunt\*, A. Gerung, and G. Perez-Hernandez, *Texas A&M University, College Station.*

The objective of this study was to determine the physical properties of emulsions stabilized with  $\kappa$ -casein.  $\kappa$ -casein was separated from acid casein using ion-exchange separation (Cayot et al. 1992). Emulsions containing 0.3%  $\kappa$ -casein and 3% butteroil were heated to 65°C and homogenized at 20, 60 and 100 MPa. Particle size distribution, rheological properties, heat stability, and the effect of rennet on the coagulation properties of the emulsions were studied. Storage stability was determined by measuring the particle size at the top and bottom of emulsions after 1, 7 and 14 days of storage. Particle sizes (dvs) of the emulsions were 0.738, 0.291 and 0.115  $\mu$ m for emulsions homogenized at 20, 60 and 100 MPa respectively. The homogenization pressure did not affect the viscosity of the emulsions, the average viscosity was 1.20 cP and emulsions had a Newtonian behavior. The addition of rennet caused the mean viscosity to increase from 1.20 to 3.74 cP. Significant differences in particle size were not found in the emulsions after heating. Emulsions homogenized at 100 MPa were more stable than emulsions homogenized at 20 and 60 MPa during the storage period.  $\kappa$ -casein can be used to prepare stable emulsion with butteroil.

**Key Words:**  $\kappa$ -Casein, Emulsion Stability, Physical Properties

**T272 Probiotic, fiber fortified, fat free plain yogurt.** K. J. Aryana\*, *Louisiana State University Agricultural Center, Baton Rouge.*

Probiotic bacteria exert benefits on the gastrointestinal health. High fiber intakes lower the risk of coronary heart disease and certain cancers. The objective was to determine whether or not the incorporation of a combination of probiotic bacteria and fibers impact the physico-chemical and sensory characteristics of fat free plain yogurt. Six different fibers namely Fibergum, Fibersol, Benefiber, Hydrobind, QC-40 and Inulin (ST-Gel) were incorporated at the rate of 1% w/v separately in the yogurt mixes. The total solids were kept constant in the control with non fat dry milk. Yogurt mixes were homogenized, batch pasteurized, cooled and yogurt culture (*Lactobacillus bulgaricus* and *Streptococcus thermophilus*) was added. This was immediately followed by further inoculation of the mix with a probiotic culture containing *Lactobacillus acidophilus*, *Bifidobacterium*, and *Lactobacillus casei*. The inoculation rates with probiotic bacteria were 0, 0.02% v/v mix. The yogurt attributes studied were syneresis, viscosity, pH, color (L\*, a\*, b\*), sensory flavor, body and texture and appearance. Yogurts manufactured with Hydrobind exhibited significantly ( $p < 0.05$ ) the least amount of syneresis (released whey) followed by Benefiber. The use of the remaining fibers resulted in syneresis which were not significantly different from the control. Yogurt manufactured with Hydrobind was significantly ( $p < 0.05$ ) the most viscous compared to the control yogurt and yogurts with other fibers. The pH of the yogurts were not significantly ( $p < 0.05$ ) impacted by the incorporation of the above mentioned fibers. Yogurts with Fibersol, Benefiber and QC-40 had significantly ( $p < 0.05$ ) higher L\* (Lightness) values compared to the other yogurts. Significantly highest a\* and b\* values were recorded for yogurts manufactured with Hydrobind and Benefiber respectively. Flavor and body and texture scores for yogurts with ST-Gel, QC-40 and Fibersol were not significantly ( $p < 0.05$ ) different from the control. The appearance scores of yogurts with Fibergum and ST-Gel were high and did not differ significantly ( $p < 0.05$ ) from the control. Probiotics along with different fibers favorably impacted different attributes of fat free yogurts.

**Key Words:** Health, Fermented, Dairy

**T273 Fat free plain set yogurts fortified with minerals.** K. Achanta\*<sup>1</sup>, K. J. Aryana<sup>2</sup>, and C. Boeneke<sup>2</sup>, <sup>1</sup>*Louisiana State University*, <sup>2</sup>*Louisiana State University Agricultural Center.*

The health benefits of various minerals are well documented in literature. Whether or not the incorporation of various minerals impacts the physico-chemical characteristics of yogurt is not clearly understood. Seven different minerals namely, iron, magnesium, zinc manganese, molybdenum, chromium and selenium were incorporated separately into the yogurt mixes at 25% of their respective recommended dietary allowances. The various attributes studied on the yogurts were viscosity, color (L\*, a\*, b\*), pH, syneresis, flavor, body, texture and appearance. No significant difference was observed in viscosity, color (L\*, a\*, b\*), pH, syneresis, body, texture and appearance for yogurts fortified with minerals when compared to the control yogurt. The flavor scores of selenium fortified yogurt were significantly lower from that of the control yogurt. Fortification of yogurts with the above mentioned minerals can be accomplished without adversely affecting the product characteristics.

**Key Words:** Health, Dairy, Fermented

**T274 Effect of emulsifying salts on texture of pasteurized process Cheddar cheese.** N. Shirashoji<sup>\*1,2</sup>, J. J. Jaeggi<sup>2</sup>, and J. A. Lucey<sup>2</sup>, <sup>1</sup>*Food Research & Development Laboratory, Morinaga Milk Industry Co., Japan*, <sup>2</sup>*University of Wisconsin, Madison*.

A detailed understanding of the influence of various emulsifying salts (ES) on process cheese functionality is important to control product quality and its end-use application. Model process cheeses were made in preliminary trials from 3-4 months old Cheddar cheese with trisodium citrate (TSC), tetrasodium pyrophosphate (TSPP) or polyphosphate salts (1-3%) that was heated at 80°C for 2 min using a bench top blender. Hot melted cheese was poured into pouches and stored at 3-5°C for 7 d. Small amplitude oscillatory rheology (SAOR) was used to study the rheological properties using a temperature sweep (frequency 0.08 Hz, strain 0.5%) from 5-85°C at a heating rate of 1°C/min. Melting properties of process cheese were measured by UW-Meltprofiler. Uniaxial compression of cheese was determined by compression to 20% of original height. Acid-base titration method was used to determine the concentration of residual insoluble calcium phosphate. Initial results from these model cheeses indicated that the storage moduli values between 40 to 85°C of cheese made with polyphosphate were higher than those with TSC, which had excellent meltability. A low concentration of TSPP resulted in cheese that had greatly reduced melt. Uniaxial compression showed that cheese with added polyphosphate had higher hardness and lower adhesiveness values than cheese made with TSC. Titration curves of process cheese made with TSC resulted in a reduction in the buffering peak at pH 4.8 as the concentration of ES increased. The buffering peak at pH 4.8 is caused by residual insoluble calcium phosphate. This buffering peak shifted to a lower pH value (pH 4.04.2) as the concentration of added polyphosphate increased. Currently pilot plant scale cheese trials with these ES and various heat treatments are being performed and will be reported.

**Key Words:** Texture, Process Cheese, Melt

**T275 Probiotic, fat free, no sugar added ice cream.** M. Summers<sup>\*</sup> and K. J. Aryana, *Louisiana State University Agricultural Center, Baton Rouge*.

Probiotic bacteria exert benefits on the gastrointestinal health. The objective was to determine whether or not the incorporation of probiotic bacteria impacts the physico-chemical and sensory characteristics of fat free no sugar added ice cream. A fat free, no sugar added ice cream mix was homogenized, vat pasteurized, cooled, and aged. Prior to freezing, vanilla flavor was added. The mix was inoculated with a probiotic culture containing *Lactobacillus acidophilus*, *Bifidobacterium* and *Lactobacillus casei*. Mixes were inoculated at rates of 0, 0.002, 0.02 and 0.2 %v/v. Immediately after inoculation the mixes were frozen. The attributes studied on the mixes were viscosity and pH. Attributes studied on the ice creams were color, meltdown time for first 15 ml, meltdown ml after 60 minutes, and sensory flavor, body and texture. The probiotic ice creams had significantly higher L\* and b\* values compared to the control. The a\* values for the probiotic ice creams were significantly lower than the control. There were no differences in L\*, a\*, and b\* values among the probiotic ice creams. The pH of the control was significantly lower compared to the probiotic ice creams. There were no significant differences in pH among the probiotic ice creams. There was no significant difference in the meltdown time for first 15 ml, meltdown ml after 60 minutes, sensory flavor, and body and texture of the ice creams. Incorporation of probiotic bacteria impacted some of the physico-chemical characteristics of fat free no sugar added ice cream.

**Key Words:** Health, Dessert, Dairy

**T276 Effect of insoluble calcium phosphate on cheese functionality.** J. Choi<sup>\*1</sup>, D. S. Horne<sup>2</sup>, M. E. Johnson<sup>1</sup>, and J. A. Lucey, <sup>1</sup>*University of Wisconsin, Madison*, <sup>2</sup>*Charis Food Research, Scotland*.

We hypothesized that loss of insoluble Ca from casein could be responsible for softening and flow of cheese. To test this hypothesis, skim milk was directly acidified with lactic acid to pH 6.0, 5.8, 5.6 and 5.4. In another trial, EDTA (0, 2, 4, and 6 mM) was added to skim milk, and milk was directly acidified to pH 6.0. Both types of milks were processed into cheese. The proportion of insoluble Ca was determined by acid-base titration method. Dynamic low amplitude oscillatory rheology was used

to measure the viscoelastic properties of cheese during heating from 5 to 80°C. To reduce the effect of proteolysis, viscoelastic properties were measured 10 h after pressing. The moisture content in all the cheeses was the same (55%), as cheesemaking procedures were modified to obtain similar moistures. The loss tangent maximum (MaxTan) increased (i.e. more flow) during heating, and for cheese made from milk preacidified to pH 6.0, 5.8, 5.6, and 5.4 it was 1.5, 2.9, 4.0, and 4.8, respectively. MaxTan of cheese made from milk with 0, 2, 4, and 6 mM EDTA were 1.5, 1.9, 2.5, and 3.4, respectively. The cheese pH was 5.7, 5.6, 5.4, and 5.3 for cheeses made with milk acidified to pH 6.0, 5.8, 5.6, and 5.4, respectively, and all cheeses from EDTA trials had the same pH (5.7). When the proportion of insoluble Ca in cheese made from milk acidified to pH 6.0 was set as 100%, there was 85, 71, 63% residual insoluble Ca in cheese made at pH 5.8, 5.6, and 5.4, and 96, 83, 80% for 2, 4, and 6 mM EDTA cheese, respectively. Preacidification of milk resulted in a reduction in total Ca and decreased the proportion of insoluble Ca and both could contribute to the increased softening and flow observed in lower preacidification cheeses. Addition of EDTA reduced the proportion of insoluble Ca while there was a only slight reduction in total Ca and pH was constant. The greatly increased melt with higher levels of EDTA was due to the reduction in insoluble Ca.

**Key Words:** Insoluble Calcium Phosphate, Cheese Functionality, Loss Tangent

**T277 Texture and microstructure of full fat and low fat Cheddar cheeses fortified with chitosan.** K. J. Aryana<sup>\*</sup> and M. C. Beck, *Louisiana State University Agricultural Center, Baton Rouge*.

Chitosan is a fat absorbing fiber. Adding chitosan to full fat and low fat Cheddar cheeses could make it possible to enjoy the advantages of fat (texture, flavor, mouthfeel) and avoid the disadvantage by preventing fat absorption in the intestine. The objective was to elucidate whether or not incorporation of chitosan in full fat and low fat Cheddar cheeses influences the texture and microstructure of cheese. Two types of chitosan namely granular and 90% high density were incorporated during cheese making at 0, 0.5 and 1.5% w/w fat in cheese. Texture was determined using a TA.XT plus texture analyzer and the microstructure was determined by scanning electron microscopy. The fracture stress and strain of the full fat and low fat control cheeses were significantly (p<0.05) higher compared to the cheeses with chitosan. Incorporation of chitosans at the highest concentrations resulted in cheeses with compact surface microstructures compared to the control. Chitosan incorporation in cheese at 1.5% w/w fat impacted the texture and microstructure of full and low fat Cheddar cheeses.

**Key Words:** Fat, Dairy, Health

**T278 Quantification of volatile flavor compounds in fresh and different off-flavor lowfat milks.** L. L. Francis, D. H. Chambers, I. J. Jeon, and K. A. Schmidt<sup>\*</sup>, *Kansas State University, Manhattan*.

Various chemical compounds contribute to the naturally pleasant flavor of milk, however with time and unwanted reactions, flavor loss is inevitable. This study was done to quantify and compare chemical compounds in "various flavors" of lowfat milk for identification of critical compounds that contribute to fresh milk flavor. Fresh milk (2d) was used to purposely prepare altered milks such as light oxidized and high acid. Lacks freshness was a 2 wk prior production milk maintained at 4°C in the dark. For SPME analysis, 75µm Carboxen/PDMS fiber sampling at 60°C for 30 min was used to collect volatile compounds in the milk headspaces which were subsequently analyzed by GC-FID for quantification. In addition all milks were analyzed for compositional contents and microbial counts. This experiment was replicated twice. Results from this study provide evidence that fresh milk flavor cannot be defined by the concentration of pentanal, hexanal, 2-heptanal, benzaldehyde, 2-butanone, and octanal only. Trends showed that light oxidized milk had a lower concentration of octanal and a higher concentration of hexanal than did fresh milk. When comparing oxidized milks exposed to light (200 ft candles) at various times (1 and 3 h), pentanal and 2-butanone concentrations increased as light exposure time increased. High acid milk possessed higher concentrations of benzaldehyde and 2-butanone, but had a lower concentration of octanal than did fresh milk. Lacks freshness milk had a higher concentration of pentanal and a lower concentration of octanal than did the fresh milk. All milks had similar

fat, total solids, and viscosity values. The lacks freshness and high acid milk had higher total plate counts than did the other milks which were considered equivalent. For this study fresh milk had a higher octanal concentration than did the off-flavored lowfat milks, which may suggest that octanal or a defined ratio of octanal to another compound is an important contributor to fresh milk flavor and, thus deserves further study.

**Key Words:** Milk, Flavor, Compounds

**T279 Serving temperature effects on milk flavor, milk aftertaste, and volatile compound quantification in nonfat and whole milk.** L. L. Francis, S. H. Kong, D. H. Chambers, I. J. Jeon, and K. A. Schmidt\*, *Kansas State University, Manhattan.*

Teenagers find the flavor and aftertaste of milk more acceptable when milk is served cold. However, describing the flavor and aftertaste of milk and correlating it to its chemical composition have not been reported. The objectives of this study were to describe the flavor and aftertaste of milk, and quantify the headspace volatiles of nonfat and whole milk as a function of serving temperature (4, 10, and 15°C). The descriptive panel results indicated that as serving temperature increased milk flavor was described as more flat or more astringent. Nonfat milk flavor was rated as having greater sour aromatics, and being more chalky, cardboard, flat, bitter, and metallic but less sweet than the whole milk flavor. Characterizing milk aftertaste at 15 s after swallowing indicated that nonfat milk had more sour, cardboard, and cooked traits than did the aftertaste of whole milk. Characterizing milk aftertaste at 90 s after swallowing indicated that the nonfat milk was less sweet, but had more cardboard and cooked traits than whole milk. With time, aftertaste ratings decreased for sweet, cooked, and fat whereas cardboard and processed aftertaste ratings remained similar. The sour aromatics aftertaste ratings were no longer significant at 90 s. Headspace volatile compounds of milk samples served at 4 and 15°C were quantified using SPME analysis, 75 µm Carboxen/PDMS fiber sampling, done at 60°C for 30 min and then analyzed by GC-FID for quantification. Serving temperature was not significant, but nonfat milks had a higher concentration of hexanal but lower concentrations of 2-heptanone, heptanal, and benzaldehyde than did the whole milk. Correlating the headspace compounds with flavor descriptors, hexanal, which has been associated with cardboard flavors, was higher in the nonfat milk. These data provide evidence that the fat contributes to the flavor and aftertaste traits of milk. For this study milk composition was more influential to milk aftertaste as opposed to serving temperature.

**Key Words:** Aftertaste, Milk, Flavor

**T280 Evaluation of pH stability in different types of heat-treated fluid and manufactured milk products during refrigerated storage.** C. O. Maduko\*<sup>1</sup>, R. Shewfelt<sup>1</sup>, J. Frank<sup>1</sup>, and Y. W. Park<sup>2</sup>, <sup>1</sup>University of Georgia, Athens, <sup>2</sup>Fort Valley State University Agricultural Research Station, Fort Valley, GA.

Heat-induced changes in pH due to shifts in the milk salt equilibrium are largely reversible, while the re-establishment of the equilibrium on cooling is slow. Heat treatment reduces the concentrations of soluble phosphates as well as soluble and ionic calcium. Heat treatment causes the precipitation of soluble calcium to colloidal calcium phosphate, which greatly influences the stability of pH and casein micelle structure in the milk. Ten different types of commercial milk products: pasteurized cow fluid (PCF), cow evaporated (CE), cow skim fluid (CSF), cow skim powdered (CSP), cow whey (CW), pasteurized goat fluid (PGF), goat evaporated (GE), goat milk protein concentrates (GPC), soy fluid (SF) and soy powdered (SP) milks were purchased to study the pH stabilities of the milk products during two weeks storage at 4 and 13°C refrigeration and 22°C room temperature. Evaporated and powdered milks were reconstituted by adding 50 and 87.5% (v/v) deionized water to the products, respectively. All milk groups were divided into three subgroups as heat treated by pasteurization (63°C for 30 min), sterilization (121°C for 20 min), and 22°C room temperature, then pHs were determined. The range of initial pHs for PCF and CE were 6.8-6.9 and 6.4-6.5, then decreased to 6.50-6.75 and 5.97-6.16 after heat treatment at 1st day refrigerated storage. This may be attributable to heat-induced acid production from lactose degradation and precipitation of tricalcium phosphate. From day 3 to 7, there were gradual increases in pH for PCF, CE, PGF and GE by 0.05-0.67 for bovine and 0.03-0.29 for caprine products. The lowest pH reached at day 9 for fluid milks,

where a more drastic pH declines were observed in the milks stored at 4°C compared to those stored at 13°C. The pH stabilities of CE, SCP, SCP, CW, GE were better than the corresponding fluid milks. The SF and SP showed the highest pHs (above 7.0), while the GPC revealed the lowest values. Heat-treated fluid milks had better pH stability at 13°C storage than at 4°C due to the minimized effect of casein dephosphorylation and changes in phosphate equilibrium which would occur at lower temperature.

**Key Words:** pH Stability, Milk Products, Heat Treatment

**T281 Use of long-chain polyphosphates for shelf-life extension of processed cheese spreads.** L. Varga\* and S. Orbán, *Department of Dairy Science, Institute of Food Science, Faculty of Agricultural and Food Sciences, University of West Hungary, Mosonmagyaróvár, Hungary.*

The effect of a food-grade long-chain polyphosphate mixture (JOHA HBS sodium polyphosphate glassy, 69±1% P<sub>2</sub>O<sub>5</sub>) on the growth and survival of spoilage microorganisms during storage in an experimental processed cheese spread formulation containing 55% moisture and 57% fat in dry matter was evaluated. The emulsifying salt was added to the cheese blend at a concentration of 0.5% or 1.0%. A control product was also manufactured, which contained monophosphate instead of polyphosphate as emulsifying salt, with all other ingredients being identical to those in the experimental processed cheese spread. The finished products were subjected to either accelerated shelf-life testing at 37°C for 10 d or refrigerated storage at 4°C for 120 d. Microbiological analyses (enumeration of viable cell counts, sulfite-reducing clostridia, coliforms, yeasts, and molds), acidity measurements, and sensory tests were performed at regular intervals. The results obtained showed that polyphosphates had a beneficial effect on the shelf life of the processed cheese spread tested in that they significantly reduced (*P* < 0.05) the growth or survival rate of spoilage microorganisms, especially of sulfite-reducing clostridia. Polyphosphates also beneficially influenced the sensory, including textural properties of the experimental processed cheese spread. All the samples containing less than 1% polyphosphate showed signs of butyric blowing significantly earlier (*P* < 0.05) during both accelerated shelf-life tests and regular refrigerated storage than did products fortified with 1% polyphosphate. In conclusion, the suitability of the long-chain polyphosphate formulation tested for shelf-life extension of pasteurized processed cheese spreads was demonstrated.

**Key Words:** Polyphosphate, Processed Cheese, Shelf Life

**T282 Seasonal variations in chemical composition of water buffalo milk.** F. Lee\*<sup>1</sup>, J. Page<sup>2</sup>, S. Gokavi<sup>1</sup>, and M. Guo<sup>1</sup>, <sup>1</sup>University of Vermont, Burlington, <sup>2</sup>Page & Pedersen International, Ltd., Hopkinton, MA.

Production of water buffalo milk yogurt, fresh Mozzarella and other products was established in Vermont and is projected to increase steadily in the next several years. However, information on chemical composition and its seasonal variation of year-round bulk-collected water buffalo milk is limited. The objective of this study was to analyze the chemical composition of commingled raw water buffalo milk from the creamy for 12 months to provide fundamental information for yogurt and cheese manufacture. The breeds of the water buffalos were mostly Riverine, with a mix of Murrah, Nili-Rivi and Jafrabadi, and their diet included a mixture of corn silage, baylage and palletized supplements. Samples were collected on the second week of each month, beginning in November, 2002, and analyzed for total solids, fat, lactose, crude protein, ash, specific gravity, minerals and pH. Chemical composition and pH of the water buffalo milk varied slightly during the period. The contents of total solids, fat, lactose, crude protein, ash, and specific gravity were 17.86 ± 0.74, 7.20 ± 0.50, 4.61 ± 0.04, 5.02 ± 0.12, 0.92 ± 0.01, and 1.0339 ± 0.0017 %, respectively. Ranges for these composition were 16.39-18.39, 6.57-7.99, 4.49-4.74, 4.59-5.37, 0.91-0.92 and 1.0317-1.0380, respectively. Mineral contents of Ca, P, K, Mg, Na and Zn were 1798.89 ± 286.97, 1216.76 ± 199.03, 843.72 ± 141.87, 337.20 ± 80.92 and 7.48 ± 3.11 mg/kg, respectively, and remained steady throughout the year. Value of pH was 6.85 ± 0.06, with a range of 6.76-6.98. Content of total solids was higher in the months of November thru March (18.46 ± 0.19 %) when compared to April thru October (17.34 ± 0.62 %). Fat content was higher in the months of September thru January (7.66 ± 0.27 %) compared with February through August (6.80 ± 0.20 %). Crude protein level was higher from November to May (5.14 ± 0.18

%). The data showed that variations in the chemical composition of the bulk water buffalo milk occurred during the period of this study.

**Key Words:** Buffalo, Milk, Composition

**T283 Relationship between cholesterol and fat contents of commercial dairy products.** Á. Kovács<sup>1</sup>, L. Varga\*<sup>2</sup>, R. Dulicsek<sup>1</sup>, J. Szigeti<sup>2</sup>, and Z. Herpai<sup>2</sup>, <sup>1</sup>PharmaFood Inc., Pécs, Hungary, <sup>2</sup>Institute of Food Science, Faculty of Agricultural and Food Sciences, University of West Hungary, Mosonmagyaróvár, Hungary.

The aims of this study were to determine the cholesterol and fat contents of a wide range of dairy products, and to find a relationship between these two compositional attributes. Thirty-three varieties of commercial fluid milks, hard and semi-hard cheeses, condensed and dried milks, cream products, butters, buttercreams, and fermented milks were purchased from food stores located in the western part of Hungary and were then analyzed for fat and cholesterol using the Roese-Gottlieb method and the direct saponification-gas chromatographic method, respectively. Cholesterol-to-fat ratios were also calculated from the values obtained. A high correlation ( $r = 0.983$ ) was found between cholesterol and fat concentrations. Butters and buttercreams had the highest fat and cholesterol levels of the 33 varieties of dairy products tested. The nonfat varieties of dried, fermented, and fluid milks showed largely increased cholesterol-to-fat ratios as compared with the other products, which must have been due to the mechanical damage caused by cream separation to fat globule membranes because the membrane-bound cholesterol thus released remained in skim milk at a higher proportion than fat did. The results of this study can be used for various purposes such as quality control of milk products, food labeling, consumer information, and development of new dairy foods. They may also be needed when assessing fat and cholesterol intakes in epidemiological studies aimed at investigating the relation between diet and health, when formulating diets for population groups with special requirements, or when establishing dietary guidelines for the general public according to health concerns.

**Key Words:** Cholesterol, Fat, Dairy Product

**T284 Development of technology for manufacturing lactose-free fermented milks.** J. Szigeti, Á. Krász, and L. Varga\*, Institute of Food Science, Faculty of Agricultural and Food Sciences, University of West Hungary, Mosonmagyaróvár, Hungary.

Lactose intolerance is common in adult populations worldwide except for peoples with a northern European genetic background. We have developed a technology for production of lactose-free fermented dairy products. The protein content of the process milk was increased whereas its lactose level was decreased by addition of milk protein concentrate. The raw material was then inoculated with the starter cultures selected (*Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* or *S. thermophilus* and *L. acidophilus*), and the lactic acid produced during the initial stages of fermentation was neutralized using a proper mixture of sodium hydroxide and potassium hydroxide. Thereafter fermentation was run according to normal commercial practice. The lactose and glucose levels of the fermented milks thus produced were negligible and their galactose content was moderately or highly reduced, depending on the starter organisms used. The finished products did not differ in texture or flavor from regular fermented milks.

**Key Words:** Fermented Milk, Lactose, Galactose

**T285 Rheological and light scattering properties of cottage cheese-type gels made under different gelation rates.** M. Castillo\*<sup>1,2</sup>, J. A. Lucey<sup>1</sup>, and F. A. Payne<sup>2</sup>, <sup>1</sup>Department of Food Science, University of Wisconsin, Madison, <sup>2</sup>Department of Biosystems and Agricultural Engineering, University of Kentucky, Lexington.

The study of milk coagulation by a combination of acidification and rennet (i.e. mixed gels) has received very little attention when compared to rennet-induced coagulation. In cottage cheese, for example, a little rennet is sometimes added to alter the gelation characteristics. Monitoring coagulation by an objective device when cheese is made by many different manufacturing conditions would be useful to control the consistency at cutting and thereby improve the quality of cottage cheese. Gels made at different gelation rates were investigated by a randomized factorial design. Gels were made with a low rennet concentration at three

different temperatures and three different starter concentrations. Gel formation was monitored using infrared light (880 nm) backscatter and dynamic small amplitude oscillatory rheology. Increasing incubation temperature or inoculum concentration enhanced the rate of pH reduction resulting in faster network formation. When coagulation rate increased, the gels became more viscous (i.e. higher loss tangent) and less stiff (i.e. lower storage modulus). The backscatter parameter,  $t_{min2}$ , and the rheologically-determined gelation time were highly correlated ( $r = 0.992$ ,  $P < 0.0001$ ) but not significantly different ( $P > 0.36$ ), suggesting that they corresponded to the beginning of gel firming. Activation energy of network formation estimated by light backscatter decreased significantly with increasing starter concentration, which could be related to a reduction in the energy barrier against aggregation caused by enhanced acidification rate.

**Key Words:** Rheology, Light Backscatter, Cottage Cheese

**T286 Influence of natural cheese characteristics on process cheese functionality: Unmelted and melted properties.** A. C. Biswas\*<sup>1</sup>, R. Kapoor<sup>2</sup>, P. Upreti<sup>2</sup>, L. Metzger<sup>2</sup>, and K. Muthukumarappan<sup>1</sup>, <sup>1</sup>Department of Ag. & Bio. Engr., South Dakota State University, Brookings, <sup>2</sup>Department of Food Science and Nutrition, University of Minnesota, St. Paul.

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 prior to the salting step of cheese manufacture and salted at two levels (high and low) for a total of eight treatments. The eight 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). At two months of ripening each treatment was used to manufacture process cheese food using a twin-screw Blentech process cheese cooker. All of the process cheese food formulations were balanced for moisture, fat, and salt. Texture and melting characteristics of the process cheese were evaluated with several techniques including the modified Schreiber test, melt profile test, and texture profile analysis (TPA). There was a significant ( $P < 0.05$ ) decrease in melt area and softening rate and an increase in softening temp and TPA-hardness in the high Ca and P treatments (HHL, HLH, HHL, and HHH) as compared to the low Ca and P treatments (LHH, LHL, LLH, and LLL). Additionally, a significant ( $P < 0.05$ ) decrease in melt area and softening rate and an increase in softening temp and TPA-hardness was observed when the high salt treatments (HLH, HHH, LHH, and LLH) were compared to the low salt treatments (HLL, HHL, LHL, and LLL). No significant ( $P > 0.05$ ) difference was observed in the melt characteristics and hardness of the high lactose treatments (HHH, LHH, HHL, and LHL) as compared to the low lactose treatments (HLH, LLH, HLL, and LLL). This study demonstrates that the characteristics of natural cheese (calcium and phosphorus content and salt/moisture ratio) used in process cheese manufacture have a significant impact on process cheese functionality.

**Key Words:** Process Cheese, Calcium, Melt

**T287 Effect of aging on the proteolytic and rheological properties of Mennonite-style cheeses from Chihuahua, Mexico.** D. L. Van Hekken\*<sup>1</sup>, M. H. Tunick<sup>1</sup>, P. M. Tomasula<sup>1</sup>, F. J. Molina-Corral<sup>2</sup>, and A. A. Gardea<sup>2</sup>, <sup>1</sup>USDA, ARS, ERRC, Wyndmoor, PA, <sup>2</sup>CIAD, Cuauhtemoc, Chihuahua, Mexico.

The proteolytic and rheological properties of semi-hard Mennonite-style cheeses, made from raw or pasteurized milk, were measured over 16 wk of 4°C storage to evaluate the changes that occurred during aging. Samples, obtained from four different Chihuahua cheese manufacturers (two used raw milk and two used pasteurized milk), were collected within days of manufacture and stored. Degree of proteolysis (SDS-PAGE) and rheological (small amplitude oscillatory strain, torsion, and texture profile analyses) properties of the cheeses were measured at 4 wk intervals. Over the 16 wk of storage, cheeses made with raw milk produced sufficient gas to disrupt the cheese matrix and severely limit shelf life. The loss of textural integrity in raw milk cheeses was reflected in the greater rate of proteolysis (decrease in  $\alpha_{S1}$ - and  $\beta$ -casein with concomitant increase of casein fragments with molecular mass of 22-18

kDa and <14 kDa) and the decrease in shear strain at the point of fracture (ability to withstand deformation). Shear strain of the pasteurized milk cheeses increased with age. While the hardness, cohesiveness, chewiness, and shear stress and shear rigidity at the point of fracture of all cheeses decreased over time, these properties decreased more rapidly and tended to be lower for the raw milk cheeses than the pasteurized milk cheeses. Results indicate that proteolysis and shear strain are good indicators of differences in the cheese matrix between the aging raw milk and pasteurized milk cheeses.

**Key Words:** Hispanic-Style Cheese, Aging, Rheology

**T288 Influence of natural cheese characteristics on process cheese functionality: Dynamic viscoelastic properties.** A. C. Biswas\*<sup>1</sup>, R. Kapoor<sup>2</sup>, P. Upreti<sup>2</sup>, L. Metzger<sup>2</sup>, and K. Muthukumarappan<sup>1</sup>, <sup>1</sup>Department of Agricultural & Biosystems Engr., South Dakota State University, Brookings, <sup>2</sup>Department of Food Science & Nutrition, University of Minnesota, St. Paul.

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 prior to the salting step of cheese manufacture and salted at two levels (high and low) for a total of eight treatments. The eight 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). At two months of ripening each treatment was used to manufacture process cheese food using a twin-screw Blentech process cheese cooker. All of the process cheese food formulations were balanced for moisture, fat, and salt. Dynamic viscoelastic ( $G'$  and  $G''$  at  $\tan \delta = 1$ ) characteristics of the process cheese were evaluated using a Viscoanalyzer at 1Hz and 0.5% strain level. There was a significant ( $P < 0.05$ ) increase in both  $G'$  and  $G''$  values in the high Ca and P treatments (HHH, HHL, HLH, and HHH) as compared to the low Ca and P treatments (LHH, LHL, LLH, and LLL). Additionally, an increase in  $G'$  and  $G''$  values was observed when the high salt treatments (HLH, HHH, LHH, and LLH) were compared to the low salt treatments (HLL, HHL, LHL, and LLL). In the high Ca and P treatments with high lactose (HHL and HHH) a significant ( $P < 0.05$ ) increase in  $G'$  and  $G''$  was observed relative to the low lactose treatments (HLL and HLH), whereas in the low Ca and P treatments high lactose significantly ( $P < 0.05$ ) decreased  $G'$  and  $G''$  in the high salt treatments and had no effect ( $P > 0.05$ ) in the low salt treatments. This study demonstrates that the characteristics of natural cheese (calcium and phosphorus content, lactose, and salt/moisture ratio) used in process cheese manufacture have a significant impact on process cheese rheological characteristics.

**Key Words:** Process Cheese, Calcium, Rheology

**T289 Quantitative evaluation of light-oxidized off-flavors in reduced fat milk using sensory evaluation and the electronic nose.** H.-Y. Chung\*<sup>1</sup>, J. A. Partridge<sup>2</sup>, and B. R. Harte<sup>1</sup>, <sup>1</sup>School of Packaging, Michigan State University, East Lansing, <sup>2</sup>Food Science and Human Nutrition, Michigan State University, East Lansing.

Light-oxidized off-flavors in milk can occur when exposed to fluorescent light in retail dairy cases. Photosensitized oxidation of milk proteins and lipids can be initiated by light activation of riboflavin which results in generation of sulfur and carbonyl volatiles. An electronic nose equipped with 12 metal-oxide semiconductor sensors was used to analyze headspace volatiles. Reduced fat (2%) milk in glass bottles was exposed to 0, 2, 4, 8, 12, 24, 36 and 48 hours of fluorescent light (1000 lx) at 5°C. Milk in various packaging (HDPE, HDPE-TiO<sub>2</sub> and PET bottles and paper cartons) was also exposed to fluorescent light for 12 hours. Sensor responses (max dR/R<sub>0</sub>) from the electronic nose were correlated to ADSA sensory scores from a trained taste panel, using partial least square (PLS) or multilayer perceptrons (MLP) techniques. Sensory scores of 2% milk in glass bottles decreased continually with increase in light exposure to 24 hours. Milk stored in the better light barriers, i.e. paper cartons and HDPE-TiO<sub>2</sub> bottles, had slightly higher sensory scores than the others, but the differences were not statistically significant. A PLS model based on a 95°C headspace sampler technique had the lowest root mean square error (RMSE) and was a

better fit than 45°C and 70°C, as well as all MLP model temperatures. The PLS approach was to find latent component(s) from electronic nose sensor responses that were also relevant to sensory scores. It was well defined for light-oxidized milk in glass bottles, since higher light-oxidized volatiles gave higher sensor responses and lower sensory scores. Alternatively, MLP was a better model for milk stored in the other packages and exposed to light. The electronic nose has potential to be used to determine light-oxidized off-flavors in packaged milk quantitatively.

**Key Words:** Electronic Nose, Milk, Light Oxidation

**T290 Effect of pre-storage and sterilization on physico-chemical properties of goat milk during storage.** A. C. Biswas\*<sup>1</sup>, A. K. Bandyopadhyay<sup>2</sup>, P. K. Ghatak<sup>2</sup>, and K. Muthukumarappan<sup>1</sup>, <sup>1</sup>Dept. of Agricultural & Biosystems Engr., South Dakota State University, Brookings, <sup>2</sup>Dept. of Dairy Chemistry, Faculty of Dairy Technology, West Bengal University of Animal & Fishery Sciences, Kolkata, India.

Effect of pre-storage and sterilization (121°C / 1.05 Kgf/cm<sup>2</sup> pressure for 10 min) on goat milk was determined during cold (5°C) and warm (30°C) temperature storage by evaluating changes in its physico-chemical properties. Three different sterilization treatments, T1 (sterilized on the same day of milking), T2 (stored at 5°C for 24 h and then sterilized) and T3 (stored at 5°C for 48 h and then sterilized) were applied to the goat milk. The sterilized goat milk was then equally stored at 5°C and 30°C respectively and physico-chemical properties, viz. viscosity, surface tension (ST), titratable acidity (TA), pH, free fatty acid (FFA), Tyrosine value (TV), non-protein nitrogen (NPN), and hydroxymethyl furfural (HMF) values were monitored on 0, 15, 30, 45 and 60 days. The experiment revealed significant increase in viscosity, TA, FFA, TV, NPN, and HMF during storage at 5°C and 30°C. In addition, significant difference ( $P < 0.01$ ) in all physico-chemical properties was observed between the treatments (T3 showed significantly higher values compared to T2 and T1), and also for different storage duration. This study elucidated that the increase in pre-storage time at 5°C before sterilization have a significant effect on the physico-chemical properties during storage at different temperatures.

**Key Words:** Goat Milk, Sterilization, Physico-Chemical Properties

**T291 Development of Cheddar cheese for lowering blood cholesterol by phytosterol ester.** H. S. Kwak\*, H. J. Ahn, S. J. Lee, and J. Ahn, *Sejong University, Seoul, Korea.*

This study was carried out to investigate the effect of phytosterol ester addition on lowering blood cholesterol in cholesterol-reduced Cheddar cheese, which was manufactured with the milk combined with cholesterol-reduced cream and skim milk. After cholesterol reduction process by beta-CD treatment, the cholesterol removal rate was in the range of 91.2 to 92.1%. Amount of short-chain free fatty acid and free amino acids increased with an increase of phytosterol ester addition, and those were significantly different from that of control in all ripening periods. Among neutral volatile compounds, more acetaldehyde and ethanol were produced in control than other compounds in phytosterol ester-added groups. All texture values increased with an increase of phytosterol ester amount during ripening period. In sensory analysis, the scores of rancid, bitterness, Cheddar flavor and off-flavor intensities increased significantly, while texture was decreased during ripening in phytosterol ester-added groups. In animal study, total blood cholesterol lowered 18% with 8% phytosterol ester-added Cheddar cheese, which was significantly different to that of control. The present study indicated that phytosterol ester showed the lowering effect of blood cholesterol when it was added in cholesterol-reduced Cheddar cheese.

**Key Words:** Phytosterol Ester, Blood Cholesterol, Cheddar Cheese

**T292 Crosslinking of beta-cyclodextrin and the optimizing of cholesterol removal in milk by using the crosslinkage.** S. H. Kim\*, E. M. Han, J. Ahn, and H. S. Kwak, *Sejong University, Seoul, Korea.*

This study was performed to crosslink beta-cyclodextrin (beta-CD) and to find the optimum conditions of cholesterol removal using the crosslinked beta-CD in milk. Two different methods were tested using 2.3 mL epichlorohydrin and 2.5 g of adipic acid, and added into containing 250 g of crosslinked beta-CD in NaOH solution. After 24

hr magnetic stirring, the pH of solution raised to 10. The solution was washed with distilled water, and dried for 24 hrs. In a subsequent study, two different crosslinked beta-CDs were used to find the optimum conditions for cholesterol removal in milk. In both, the optimum conditions were 1% beta-CD addition, 10 min stirring time, and 800 rpm stirring speed. The rates of cholesterol removal were 80 and 75% in epichlorohydrin and adipic acid, respectively. In conclusion, the present study showed the possibility of crosslinked beta-CD development and the application to cholesterol removal process in milk.

**Key Words:** Crosslinking, Beta-Cyclodextrin, Cholesterol Removal

**T293 Simple immobilization of beta-cyclodextrin to remove cholesterol in milk and recycling.** H. S. Kwak\*, S. H. Kim, J. H. Kim, H. J. Choi, and J. Kang, *Sejong University, Seoul, Korea.*

This study was designed to determine the optimum conditions of three different factors (mixing time, mixing temperature, and tube size) in reduction of cholesterol in milk using immobilized beta-CD beads. Immobilized beta-CD glass beads were prepared at different conditions of silanization and beta-CD immobilization reactions. In result, the glass beads (diameter 1 mm) at 20 mM 3-isocyanatopropyltriethoxysilane and 30 mM beta-CD without base showed the highest cholesterol removal rate as 52%. Using above immobilized beta-CD glass beads, the cholesterol removal rate was 51.2% with 6 hrs of mixing time in 7 mm diameter tube at 10°C. After cholesterol removal from milk, the glass beads were washed for cholesterol dissociation and reused. For recycling study, the cholesterol removal rate was 52%, which was mostly same as that using new glass beads. These results indicated that cholesterol removal rate was 52% with beta-CD immobilized glass beads, however, the recycling efficiency was almost 100%.

**Key Words:** Beta-CD Immobilization, Cholesterol Removal, Recycling

**T294 Effects of microencapsulated chitoooligosaccharide addition on cholesterol-reduced milk.** H. J. Choi\*, J. Ahn, J. H. Hwang, and H. S. Kwak, *Sejong University, Seoul, Korea.*

This study was designed to develop microencapsulated chitoooligosaccharide that could be added into cholesterol-reduced milk, and to examine the changes of physical and sensory properties during storage. Coating material was polyglycerol monostearate (PGMS). The efficiency of microencapsulation was 80.08% with 10:1 ratio (w/w) as coating to core materials. When even 0.5% microencapsulated chitoooligosaccharide was added, the L, a, b values and viscosity were significantly different from that of control (uncapsulated chitoooligosaccharide added). In stability measurement of microcapsules, the releases of chitoooligosaccharide were 1.33% and 1.25% in distilled water and cholesterol-reduced milk for 15 day storage at 4°C, respectively. In a sensory analysis, the values of astringency, bitterness, and color were significantly different between control and encapsulated chitoooligosaccharide-added cholesterol-reduced milk for 7 days of storage. The present study indicated that the microencapsulated chitoooligosaccharide showed a high stability, and could be an effective means for addition in cholesterol-reduced milk.

**Key Words:** Chitoooligosaccharide, Microencapsulation, Milk

**T295 Functional properties of cholesterol-removed whipping cream treated by beta-cyclodextrin.** S. Y. Shim, J. Ahn, and H. S. Kwak\*, *Sejong University, Seoul, Korea.*

The present study was carried out to examine the changes in functional properties of cholesterol-removed whipping cream by beta-CD treatment. The cholesterol removal rate reached over 90% in cream before whipping with in all conditions (different stirring time and speed) applied. The apparent viscosity of beta-CD treated cream after whipping increased with increased stirring time and speed. Comparatively, the overrun percentage reached to 150%, and foam instability was measured as 2.5 mL deformed cream with lower stirring time (10 min) and speed (400 rpm). The TBA value of cholesterol-removed whipping cream increased from 0.08 to 0.14 stored at 4°C during 4 wk, however, no difference was found compared to that of control. Above results indicated that beta-CD treatment process for cholesterol removal did not show a profound adverse effect on functional properties of cream after whipping.

**Key Words:** Cholesterol Removal, Beta-Cyclodextrin, Whipping Cream

**T296 Development of functional properties of water buffalo milk yogurt beverage.** J. R. Huck, F. L. Lee, and M. Guo\*, *University of Vermont, Burlington.*

A prototype yogurt beverage was developed using regional water buffalo milk, probiotic cultures and inulin. Water buffalo milk is considered to be more nutritious because it contains higher levels of calcium, fat, protein and antioxidants than cows milk. Probiotic bacteria such as *L. acidophilus*, *L. casei* and *Bifidobacteria* have shown to have beneficial effects to human intestinal health and are commonly added to commercial yogurt products. Inulin and oligofructose have been documented as prebiotics to provide fermentative stimulation to probiotic cultures and direct health benefits as non-digestible dietary fiber. Three trials of prototype yogurt beverages were prepared by adding whey protein concentrate and a probiotic yogurt culture mixture to pasteurized, homogenized water buffalo milk and incubating for 5.5 h. The cooled yogurt bases were then blended with a stabilizer mixture of water, sucrose, inulin, and pectin. A flavor and an acidulant were added prior to second homogenization process and bottling. Sensory evaluation by semi-trained panelists revealed acceptable textural and taste attributes of the yogurt beverage after 24 h in refrigerated storage of 3°C. Mean chemical composition of the product consisted of 11.2% carbohydrates, 2.7% fat, 1.8% protein, 0.3% ash and pH 3.65. Visual inspection and digital photographs showed the beverage remained stable up to twelve weeks. Survivability enumeration of probiotic cultures showed only levels of *L. casei* and *Bifidobacteria* to be above 10<sup>6</sup> CFU/g at week 5. Therefore, a post-fermentation fortification of *L. acidophilus* to the yogurt beverage is recommended in order to maintain functional probiotic levels above 10<sup>6</sup> CFU/g during refrigerated storage. In conclusion, symbiotic water buffalo yogurt beverage can be developed with probiotic cultures and functional prebiotic ingredients.

**Key Words:** Water Buffalo Milk, Symbiotic, Yogurt Beverage

**T297 Effect of cheddaring temperature on moisture retention, rheological properties and proteolysis in model cheese systems.** P. J. Watkinson, C. J. Coker, C. C. Dodds, S. Hewson, B. Kuhn-Sherlock, N. J. White, and L. K. Creamer\*, *Fonterra Research Centre, Fonterra Co-operative Group Limited, Palmerston North, New Zealand.*

Removal of water from the rennet coagulum is important in cheese manufacture. Cheddaring is one of the ways that can be used to control the moisture content of a cheese. A series of model cheeses were prepared using a range of cheddaring temperatures to give cheeses with different moisture contents in order to determine the effect of cheese moisture on the development of certain rheological properties. Milk with a protein:fat ratio of 1.4:1 was acidified with acetic acid to a pH of about 6.1 and then coagulated with rennet (3.0 mL/100L). Each coagulum was cut and cooked (40°C), drained and then mixed with a measured quantity of glucono- $\delta$ -lactone (GDL). It was then cheddared in jacketed vats controlled between 10 and 60°C. The curd was then salted, hooped, pressed, wrapped, and stored at 5°C. The cheeses were sampled after storage from 2 to 184 days and then the rheological and compositional properties and intact casein were measured. Moisture contents of the cheeses were between 40 and 48% (average value over the storage time). The Hencky fracture strain (resistance to crumbling) increased with the moisture content of the cheeses and the effect was greater in the more mature cheeses. The adhesion area (adhesiveness) was similar but the modulus of deformability (stiffness) diminished with increasing moisture content and cheese maturity had a small and variable effect. The content of intact  $\alpha_{s1}$ -casein decreased with increased moisture content, except for the two-day samples, which were assumed to contain 100% intact protein. The pHs of all cheeses were between 5.76 and 5.80. A second study used a set of cheeses with moisture contents between 34 and 39% (pHs between 5.51 and 5.54) and showed similar but slightly more complex trends. There was an apparent correlation between moisture content and the extent of proteolysis and some of the rheological properties. The relationship between moisture content and proteolysis may be indirectly responsible for the changes in rheological properties being correlated with moisture content.

**Key Words:** Model Cheese, Cheddaring Temperature, Rheological Parameters

**T298 Effects of fat content on physico-chemical and sensory properties of buffalo milk dahi (yogurt).** N. Pandya\*<sup>1</sup>, S. Kanawjia<sup>1</sup>, and R. Dave<sup>2</sup>, <sup>1</sup>*Dairy Technology Department, National Dairy Research Institute, Karnal, India,* <sup>2</sup>*Dairy Science Department, South Dakota State University, Brookings.*

The use of fermented milks dates back to many centuries and dahi is one such fermented milk product occupying an important place in Indian diet satisfying the palate and nutritional requirements of human beings. Commercial production of dahi is still in infancy stage in India and very few studies are available on the effects of ingredients on physico-chemical and sensory properties of dahi made from buffalo milk. This study was aimed to optimize the fat content in buffalo milk dahi. Fat levels studied were 1.5, 3.0 and 4.5% with solids not fat maintained at 9.5% level in all the samples. It was observed that during the first 12 h of incubation, the rate of drop in pH and the rate of increase in acidity were faster in milk with 1.5 and 3.0 % fat as compared to the milk with 4.5% fat. However, after 12 h of incubation, the rate of change in pH and acidity became almost similar at all fat levels studied. Also, the optimum set time increased up to 2.5 h with the increase in fat content from 1.5 to 4.5%. Rheology and sensory properties improved significantly ( $P < 0.05$ ) with increasing fat content. With the increase in fat content from 1.5 to 4.5%, the average increase in viscosity was 22.5%, wheying off reduced by 31% and curd tension improved by 10%. Also, with increase in fat content from 1.5 to 4.5 % in dahi, the flavor scores improved from 40.7 to 48.3 out of 50, the body & texture scores improved from 35 to 38.8 out of 40.0, and there was no significant difference ( $P < 0.05$ ) in appearance scores. Keeping in view the overall sensory characteristics and different rheological properties of dahi, fat level of 4.5% was suggested for the commercial production of dahi.

**Key Words:** Buffalo Milk, Fat, Dahi

**T299 Understanding the role of proteolysis in reduced calcium Mozzarella cheese.** P. R. Thakur\* and R. I. Dave, *Dairy Science Department, South Dakota State University, Brookings.*

Calcium content plays an important role in the functional properties of cheese. Recent study showed that reduced calcium Mozzarella cheeses not only had improved softening, melting and flow characteristics, but also had higher proteolysis. The objectives of this study were to characterize the proteolysis in Mozzarella cheese at various storage periods, correlate the melt properties to the proteolysis and also study the effects of coagulants (chymosin and Sure Curd<sup>®</sup>) on the proteolysis of reduced calcium Mozzarella cheese. Mozzarella cheeses were made by direct acidification using Glucono- $\delta$ -Lactone. The milk was pre-acidified using citric acid and acetic acid to a pH of 5.9 to lower the level of calcium. No alteration in the calcium content of control cheeses was made. The composition of cheeses were kept as uniform as possible by adjusting the processing conditions. The samples were analyzed on day 1, 7, 15 and 30 for various study parameters. Proteolysis as measured by water-soluble nitrogen (WSN), TCA - soluble nitrogen and PTA - soluble nitrogen was higher in reduced calcium cheeses. The water-soluble nitrogen for reduced calcium cheeses was almost double than the control cheeses on day 1. WSN changed only a little throughout the storage period in control cheeses, but it increased in reduced calcium cheeses during storage. TCA -soluble nitrogen increased over the storage period in reduced calcium cheese while the increase in PTA - soluble nitrogen was very little. Also, the proteolysis was higher in cheeses manufactured using sure curd in comparison to the cheeses manufactured using Chymosin. The melt area for reduced calcium cheeses was 2.1 times higher than the control cheeses. Control cheeses had higher expressible serum than the reduced calcium cheese throughout the storage, which shows higher water-holding capacity of reduced calcium cheeses. The fluorescence microscopic images showed better distribution of fat within the protein matrix of reduced calcium cheeses.

**Key Words:** Reduced Calcium Mozzarella Cheese, Proteolysis, Coagulant

**T300 Milk from cows fed potato by-products indistinguishable from whole milk.** M. L. Nelson\*, M. J. Costello, M. F. Morrison, and S. Clark, *Washington State University, Pullman.*

Four multiparous Holstein cows ( $761 \pm 18$  kg body weight;  $119 \pm 2$  d in milk) were randomly assigned to a 4x4 Latin Square to determine effects of type of potato by-product in a TMR on milk production, composition, and quality. Periods were 28d (21d for adaptation, 7d for milk

collection). Cows were fed a TMR with none or 15% replacement of the grain portion with a potato by-product (filter cake, potato peels, or screen solids). Daily feed intake and milk production were quantified. Weekly milk subsamples were analyzed for milk composition. Total milk, from each cow, was collected at both milkings on d 22, pasteurized, homogenized, and cooled. Milk was evaluated by a 9 member trained sensory panel and a 40 member consumer panel in each period. Cows fed potato byproduct containing diets consumed less ( $P < 0.05$ ) DMI ( $26.6$  vs.  $20.8 \pm 0.65$  kg) with no effects ( $P > 0.05$ ) on milk production ( $41.6 \pm 0.54$  kg/d), milk fat ( $3.5 \pm 0.10$  %), or weight change ( $0.3 \pm 0.1$  kg/d). No differences ( $P > 0.05$ ) due to diet were detected in 17 milk attributes by the trained sensory panel. Consumer panels paired milk samples from potato peel-fed cows and screen solid-fed cows more than by chance ( $63.7 \pm 14.2$  %,  $59.7 \pm 11.8$  %), which was not due to milk composition or sensory attributes identified by the trained sensory panel. Potato byproducts, by replacing grain in a TMR, resulted in reduced DMI without affecting milk production, composition or sensory attributes.

**Key Words:** Milk, Potato By-Product, Sensory Evaluation

**T301 Microstructure of pasteurized Process cheese manufactured from vacuum condensed and ultrafiltered milk.** V. V. Mistry\*, A. N. Hassan, and M. R. Acharya, *MN-SD Dairy Foods Research Center, Dairy Science Department, South Dakota State University, Brookings.*

Milk concentrated by ultrafiltration (UF) or vacuum condensing (CM) to two levels of protein: 4.5% (UF1 and CM1) and 6.0% (UF2 and CM2) or Control (C) with 3.2% protein was used for manufacturing Cheddar cheese (Acharya et al. 2001. *J. Dairy Sci.* 84 (Suppl.1):306). Pasteurized Process cheeses were manufactured using a 1:1 blend of 18-week and 30-week Cheddar cheese (Acharya et al. 2002. *J. Dairy Sci.* 85: (Suppl. 1):357). The moisture content of the Process cheeses ranged from 39.3 to 40.2%. Fat content was the highest in C (35.0%) and the lowest in UF2 (31.6%). The microstructure of cheeses was evaluated using cryo-scanning electron microscopy and fluorescence microscopy. Process cheeses with the highest meltability (Control) demonstrated a structure in which fat globules of varying size were uniformly distributed in a porous protein matrix. The porosity of the protein matrix decreased with decreasing meltability (UF2, CM1 and CM2). Cheeses with minimal porosity were the hardest; 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). Similarly, viscosity of molten cheese at 80°C correlated to this structural feature and was higher in 6.0% protein treatments (1043 cp-UF2 and 1208 cp-CM2) than in 4.5% protein treatments (855 cp-UF1 and 867 cp-CM1) and in C (557 cp). It was also interesting to note that the fat globules in control cheeses were surrounded by greater void space relative to the other cheeses. The application of concentrated milks for Cheddar cheese-making influences Process cheese functionality and structure.

**Key Words:** Process Cheese, Concentrated Milk, Microstructure

**T302 Flavor and stability of pasteurized milk with elevated levels of conjugated linoleic acid and vaccenic acid.** J. M. Lynch<sup>1</sup>, A. L. Lock<sup>2</sup>, D. A. Dwyer<sup>2</sup>, R. Norbaksh<sup>3</sup>, D. M. Barbano\*<sup>1</sup>, and D. E. Bauman<sup>2</sup>, <sup>1</sup>*Northeast Dairy Foods Research Center, Department of Food Science, Cornell University, Ithaca, NY,* <sup>2</sup>*Department of Animal Science, Cornell University, Ithaca, NY,* <sup>3</sup>*Institute of Standards and Industrial Research, Mashhad, Iran.*

The objectives in this study were to determine if flavor differences between 2% fat pasteurized milks with and without elevated vaccenic acid (VA) and cis-9, trans-11 CLA levels could be detected over the commercial shelf life of the product and to determine if milk with elevated VA and cis-9, trans-11 CLA levels was more susceptible to light-induced oxidative flavor defects. Cows were fed either a control diet ("control" diet) or the same ration supplemented with 2% soybean oil and 1% fish oil ("CLA" diet). Control and CLA raw milks were collected and separated into cream and skim. The skim and cream from each treatment were combined to achieve 2% fat milk. The milks were pasteurized, homogenized and stored in commercial clear plastic milk containers at 4°C. Oxidation was induced by exposing half of the containers to fluorescent light. Testing was conducted at 1, 7 and 14 days post-pasteurization. Average cis-9, trans-11 CLA content of the control and CLA milks was 0.52 and 4.74 g/100g fatty acids, respectively (812% increase). Average

VA content of the control and CLA milks was 1.43 and 12.06 g/100 g fatty acids, respectively (743% increase). There was no effect of light exposure on fatty acid composition either initially or over the 14-day storage period. Although VA, cis-9, trans-11 CLA and degree of unsaturation were significantly elevated in the CLA milk, untrained panelists were unable to detect flavor differences either initially or over time in 15 out of 16 triangle test evaluations. Similarly, sensory results indicated no difference in susceptibility to the development of oxidized off flavor between the control and CLA milks, even when oxidation was induced by light exposure.

**Key Words:** CLA, Fluid Milk, Flavor

**T303 Evaluation of long term frozen-storage effect on chemical changes in soft and semi-hard goat milk cheeses.** J. H. Lee\*, Y. W. Park, and B. L. Gadiyaram, *Fort Valley State University, Fort Valley, GA.*

Freezing cheese is not common practice in dairy industries due to the high production costs and possible adverse effects on physico-chemical, rheological, and sensory qualities of the frozen products. However, frozen-storage of cheese as a food technological approach may be essential for extending marketability of caprine milk products. Three lots of plain soft (PS) goat cheeses were purchased, and 3 lots of Monterey Jack (MJ) goat cheeses were manufactured at the University dairy plant to study changes in chemical parameters such as pH, acid degree value (ADV), water soluble nitrogen (WSN) profiles during 6 months of extended frozen and refrigerated storage. Each cheese variety was subdivided into 4 equal portions, and stored at 4°C for 4 weeks (0, 14, 28 days) as the unfrozen control, and the other three subsamples were frozen (-20°C) and stored for 0, 3 and 6 months, then immediately thawed the next day at 4°C, followed by aging at 4°C for 4 wks. For PS cheese, ADVs were increased ( $P < 0.05$ ) with frozen storage time (0.5 to 0.7) and subsequent refrigeration time (0.5 to 0.7). However, the levels of WSN were only influenced by subsequent refrigeration time (9.2 to 10.5). The pH (4.0 to 4.1) was not affected by freezing and subsequent refrigeration. Both proteolysis and lipolysis properties of PS cheese were affected by freezing and subsequent refrigeration. For MJ cheese, neither pH nor ADV was affected by freezing/subsequent refrigeration in MJ sample. The pH was ranged from 5.8 to 6.1 during the experimental period; the ADV was varied from 1.2 to 1.5. WSN contents of MJ were significantly decreased against frozen storage time from 0 to 6 mo (16.6 to 15.3), whereas subsequent refrigeration did not influence to the WSN. Increasing frozen storage time may influence the protein degradation in MJ. Frozen storage time and subsequent refrigeration impacted on flavor compounds and protein degradation, but not on the chemical properties related to lipolysis (ADV) and pH.

**Key Words:** Goat Cheese, Long Term Frozen-Storage, Chemical Changes

**T304 Feasibility study of forming a California cheese aging cooperative.** B. A. Reed\*, *University of California Cooperative Extension, Orland.*

California artisan cheesemakers were contacted to assess their interest in the development of a cheese aging cooperative and collect information on the scope of services desired. Twelve cheesemakers agreed to

participate in the survey. Average cheese production was 41681 kg/yr with a range of 5443 to 145150kg/yr. Facilities made an average of 6 cheese varieties with a range of 1 to 12. The collective volume of cheese aged <60 d, 2-5 mo, 6-12 mo, 13-23 mo and >2yr was 179750, 141657, 155002, 42547 and 2132 kg respectively. Cheese shipped from the plant cut and wrapped versus whole wheels was 34.2% and 65.8% respectively. Cheese makers reported primary barriers to expansion as lack of storage or processing space (4), or the cost of space (1), cash flow (3), milk supply (1), expertise in aging (1), and distribution (1). Secondary barriers identified were, processing space (2), storage space (1), labor (2) and housing costs for labor (1), freight costs (1), (unspecified) problems with distribution (2), lack of cross docking and drop points to improve distribution (1), risk and cost of expansion (1), and cash flow (1). For the producers interested in using a facility, features/services offered by a facility ranked in importance on a 10 point scale from highest to lowest were, retain ownership and identity (8.8), added storage space (8.5), assistance with aging (7.2), cash advance for cheese (6.3), marketing and distribution assistance (6.2), better risk protection (5.0) and unique marketing identity (4.7). Financial analyses developed from the survey information showed an average cost for aging cheeses in a cooperative at \$1.37, \$0.95 and \$0.95/kg for years 1, 2 and 3 respectively with 5 initial member/owners and a rolling monthly inventory of 11340 kg. The charge needs to drop to \$0.44/kg for the aging cost not to exceed the price differential for an aged cheese.

**Key Words:** Cheese Aging, Costs, Cooperative

**T305 Release of antioxidants from biodegradable films into dry milk products and food simulating liquids.** M. van Aardt<sup>1</sup>, S. E. Duncan\*<sup>1</sup>, J. E. Marcy<sup>1</sup>, T. E. Long<sup>2</sup>, S. F. O'Keefe<sup>1</sup>, and S. R. Sims<sup>3</sup>, <sup>1</sup>*Food Science and Technology, Virginia Tech, Blacksburg,* <sup>2</sup>*Chemistry, Virginia Tech, Blacksburg,* <sup>3</sup>*Eastman Chemical Company, Kingsport, TN.*

Poly(lactide-co-glycolide) (50:50) films loaded with antioxidants (i) 2%  $\alpha$ -tocopherol, and (ii) a combination of 1% butylated hydroxytoluene (BHT) and 1% butylated hydroxyanisole (BHA), were used in an antioxidant release study in water and Miglyol 812<sup>®</sup> at 4°C and 25°C, as well as a study on the effect of these films on dry whole milk and dry buttermilk stability. BHT was released through the hydrolytic degradation of the polymer when stored in water at room temperature for eight weeks. As expected, polymer degradation did not take place when antioxidant-loaded films were stored in whole milk powder (3.01% moisture) and buttermilk powder (4.60% moisture). However,  $\alpha$ -tocopherol, BHA, and BHT were released through diffusion from 0 mg/kg to 21.9, 60.0, 192.0 mg/kg milkfat, respectively, in whole milk powder after four weeks of storage at 25°C. Buttermilk powder did not show increasing antioxidant content, which might be due to a much lower fat content (2.35%), as compared to whole milk powder (24.48%). Milkfat stability was measured by determining hexanal, pentanal, and heptanal content. Although limited reductions were observed in these volatiles in control- and antioxidant-treated powders, pentanal content was significantly decreased for the first three weeks of storage when buttermilk powders were packaged in contact with BHA/BHT-loaded PLGA films.

**Key Words:** Antioxidants, Lipid Oxidation, Milk Powder