1010 Degradation of cell wall polysaccharides by a combination of carbohydrase enzymes: In vitro and in vivo studies. X. F. Meng*, F. O. Omogbenigun, C. M. Nyachoti, and B. A. Slominski, *Department of Animal Science, University of Manitoba, Winnipeg, MB, Canada*.

Non-starch polysaccharides (NSP) in feedstuffs of plant origin affect nutrient utilization by non-ruminant animals mainly due to the antinutritive effects associated with water-soluble and viscous polysaccharides and nutrient encapsulating effect of the cell walls. In vitro incubation studies were carried out to determine if various carbohydrase enzyme complexes contained appropriate activities to target NSP of soybean meal, canola meal and peas. A more pronounced depolymerization of the NSP was achieved when selected enzyme preparations were used in concert. When compared to the control (non-enzyme) treatment, the degree of NSP hydrolysis and/or disruption of the cell wall structure averaged 19.5, 34.0 and 24.7% for soybean, canola meal and peas, respectively. Effective enzyme combinations were studied further in digestibility trials with poultry and swine. In the broiler chicken assay, the digestibility of NSP increased from 2.0 to 16.9% in birds fed enzyme supplemented soybean/canola meal/peas/wheat based-diet. In a subsequent, 3-wk growth performance trial, an improvement ($P<0.05$) in body weight gain (646 vs 682g) and feed conversion ratio (1.43 vs 1.39) was noted with enzyme supplementation. In adult roosters fed the coarsely ground canola seed, the digestibility of NSP increased from 11.1 to 30.1% for the enzyme supplemented sample and resulted in an improvement ($P<0.05$) in energy utilization (4133 vs 4735 kcal/kg DM). In the pig trial, ileal NSP digestibility averaged 10.2 and 26.0% for the control and enzyme supplemented wheat/soybean/canola meal/peas-based diets, respectively. This was followed by the same magnitude of difference ($P<0.001$) in dry matter digestibility (62.5 vs 71.3%). Only a trend towards improved ADG (231 vs 251g; $P=0.145$) and FCE (1.87 vs 1.66; $P=0.08$) with enzyme supplementation was noted.

Key Words: Non-starch polysaccharides, Cabohydrase enzyme, Non-ruminants

Dairy Foods
Cheese and Sensory

1011 A survey of California specialty cheese consumers' opinions and shopping habits. B. A. Reed*[1] and C. M. Bruhn[2], [1] *University of California Cooperative Extension, Glenn County,* [2] *Center for Consumer Research, University of California, Davis*.

To improve marketing effectiveness for small-scale farmstead cheese producers, the shopping habits and opinions of specialty cheese consumers were gathered by telephone and focus group interviews in three locations. Volunteers were recruited from specialty cheese counters in upscale grocery stores in Northern California. Of the 47 consumers surveyed by telephone, 9% purchased specialty cheeses several times per week, another 38% purchased cheeses weekly. Specialty cheese purchases represented 75% of all cheese purchases for 48% of those interviewed. Of those interviewed, 26% bought more than 0.45 kg of cheese in any given purchase. All of the consumers (100%) reported eating cow's milk, 96% ate goat or sheep milk cheese, 98% ate aged hard cheese, 94% ate veined cheeses, 81% ate soft surface-ripened cheeses. Respondents purchased European specialty cheeses most frequently (57%) followed by California specialty cheese (32%). Thirty four of the volunteers interviewed by telephone also participated in focus groups. Buying locally produced foods was very important to 38% of focus group participants, while buying foods directly from family-owned farms was rated as very important by 15% of participants. Buying foods that have potential health benefits was rated as very important by 53% of participants. Although specialty cheese consumers considered themselves food experimenters and not afraid to sample new cheeses, generally they would not purchase a new cheese without tasting it first. Consumers relied heavily on specialty grocery staff recommendations for guidance in cheese selection and valued food descriptions that included origin, flavor, texture, recommended uses and food and wine pairings. When shopping, consumers appreciated unlimited tasting opportunities and did not want to feel hurried when making a cheese selection. Few consumers mentioned price when discussing purchase decision criteria unless making purchases for a family. Consumers place a high value on perceived freshness and quality. Cheese makers should take time to do in-store sampling, distribute their product to stores that place a high emphasis on customer service and be sure the cheese sales staff are well educated about the unique properties of their product.

Key Words: Specialty cheese, Consumers, Focus groups

1012 Cheese making properties of milk enriched with β-casein. Sylvie Haché* and Daniel St-Gelais, *Food Research and Development Centre, Agriculture and Agri-Food Canada, St-Hyacinthe, Quebec*.

In this study, the impacts of milk enriched with β-casein on bacterial growth, coagulation properties and composition of Cheddar cheese like-product were investigated. Enriched milk was adjusted to 2.67 (EM1), 2.86 (EM2), or 3.04% (EM3) of casein with a β-casein powder. Fresh milk (2.49% casein) was used as a control (CM). The casein to fat ratio for cheese milks was adjusted to 0.67, 0.69, 0.72 and 0.74, respectively with fresh cream. The evolution of population of proteolytic (PRT^+) and non-proteotylic (PRT^-) strain of lactococci in all cheese milks was determined on M17 agar. Coagulation properties were determined with a formagraph and by using a turbidity method. Cheeses obtained from control and enriched milks were analysed for moisture, protein, fat and ash. During cheese ripening, the evolutions of proteolysis (WSN) and firmness were determined. The experiment was replicated six times. A factorial design was used to compare different treatments. Results indicated that the growth of lactococci was not affected by β-casein concentration in cheese milks. Rennet curd formation was affected by the β-casein in enriched milks. Coagulation time increased with β-casein concentration. The moisture (41.1%) and ash (3.4%) contents were higher, whereas the protein content (23.2%) was lower in control cheese than in cheeses enriched with β-casein (39.7, 3.0 and 24.6%, respectively). In addition cheese yields increased with β-casein concentration. During cheese ripening, the evolution of proteolysis was similar for all cheeses. Firmness for all cheeses decreased continuously but was lower in control cheese. Cheese could be produced from milk enriched with β-casein. However, cheese production must be modified.

Key Words: Enriched milk, Cheese, β-casein

1013 Impacts of salt on the composition, proteolysis and functional properties of Mozzarella cheese. Annie Caron*[1], Daniel St-Gelais[1], and Pierre Audet[2], [1] *Food Research and Development Centre, Agriculture and Agri-Food Canada, St-Hyacinthe, Quebec,* [2] *Agropur, Granby, Canada*.

In this study, the impacts of different salting procedures during Mozzarella cheese production on the composition, distribution of salt and moisture, proteolysis, and some functional properties were investigated. For the control Mozzarella (CM) cheese the fresh curd after stretching and forming was immersed in a salt brine solution (19% NaCl; 10 h at 4C). The experimental Mozzarella (EM) cheese was salted on curd before stretching (1.2% NaCl), during stretching (5% NaCl) and finally in brining (19% NaCl; 30 min at 4C). Mozzarella cheeses were produced from milk enriched to 3.7% of total proteins with an UF milk retentate. The protein to fat ratio was adjusted to 1.33. All cheeses were stored at 6C for 14 d. Cheeses were analyzed for moisture, proteins, fat, ashes, calcium, salt, and residual rennet (RR) activity. The distribution of salt, moisture, proteolysis, melted cheese firmness and spreading cheese property was determined from surface (S) to centre (C). The experiment was replicated four times. The moisture (46.5%), salt (1.0%) and ash (2.9%) contents were lower, whereas the protein (26.6%), fat (21.9%), calcium (0.79%) contents were higher in CM than in EM cheeses (48.5, 1.5, 3.2, 25.1, 21.3 and 0.62%, respectively). The RR activity was higher in CM (8.0%) than in EM cheeses (6.6%). In general, the protein and fat losses in whey and in water during stretching were higher for EM than for CM cheeses. During storage, the salt and moisture distribution from surface to centre was more uniform in EM than in CM cheeses. The proteolysis was higher in CM than in EM cheeses, mainly on surface cheeses. The melted cheese firmness was higher, whereas the spreading properties were lower in CM than in EM cheeses. By modifying the

salting procedures during Mozzarella cheese production it is possible to change proteolysis and functional properties.

Key Words: Mozzarella cheese, Fuctional properties, salt

1014 Effect of pre fermentation of different portions of milk retentate on Prato cheese composition and proteolysis. J.R.F. Dornellas, L.M. Spadoti, C.R. Cunha, and S. Massaguer-Roig*, *Universidade Estadual de Campinas, Campinas, SP, BRASIL*.

Prato cheese is the second most consumed cheese in Brazil. It is a washed, semi cooked curd cheese similar to Gouda and Edam cheeses. Research on semi hard cheeses manufacture with milk ultrafiltration (M UF) reported on the literature has used partial concentration. Among the M UF advantages are production maximization, economy on water consumption and effluent treatment, better products standardization and eventual yield increase. However M UF cheeses have on their composition whey proteins, which affects proteolysis. The objective was to study the effect of pre fermentation of different portions of the retentate, with lactic starters, on chemical composition and proteolysis of Prato cheese obtained by M UF with a volumetric concentration factor of 3:1. Milk was concentrated at 55°C in a UF unit with Carbosep mineral membranes, of 20 000 Daltons cut off, at inlet and outlet pressure of 2.0 and 1.0 bar. Cheese was manufactured by the traditional process with enzymatic coagulation (Bela Vista Calf Rennet-90% chymosin) at 35°C/40 min., curd cutting, 20% whey withdrawal, direct curd cooking by hot water (80°C) addition, molding, pressing and curing at 7°C. Experimental conditions in fermentation of zero, 10 and 20% of the retentate up to pH 5.0 (treatments 2, 3 and 4) previously to coagulation and compared to a cheese manufactured with non UF milk (treatment 1). Experimental design was a random block with three replications. Cheeses were compared with respect to gross composition and proteolysis. All four treatments presented a similar composition behavior. Treatments 3 and 4 presented lower pH and higher acidity and also a significantly larger ($p<0.05$) proteolysis index with respect to treatments 1 and 2. However treatments 1 and 2 did not present a significant difference ($p>0.05$) between them, and the same happened with treatments 3 and 4. On treatments 3 and 4 the retentate pre fermentation took 12 hours which allowed the activation and growing of the lyophilized starter with consequent larger production of proteolytic enzymes responsible for the secondary proteolysis, and also resulted in more intense acidification with a resulting lower pH and favoring chymosin action resulting in a larger primary proteolysis.

Key Words: Cheese, Ultrafiltration, Proteolysis

1015 Composition, protein and fat recovery and yield evaluation on Prato cheese manufactured with Ultrafiltration concentrated milk. L.M. Spadoti, J.R.F. Dornellas, C.R. Cunha, and S. Massaguer-Roig*, *Universidade Estadual de Campinas, Campinas, SP, BRASIL*.

Prato cheese is the second most consumed cheese in Brazil. It is a washed, semi cooked curd cheese similar to Gouda and Edam cheeses. Semi hard cheese manufacture with ultrafiltrated milk (UF M) tends to promote a yield increase, however technological problems such as flavor and texture defects can occur. Reported research has indicated that such defects can be minimized by means of pre fermentation of a portion of the retentate. The objectives of this research were to evaluate the gross composition, the protein and fat recovery, the yield, and the adjusted yield on Prato cheese manufactures with non concentrated milk (treatment 1), and with UF M up to a volumetric concentration ratio of 3:1 and different portions of retentate pre fermentation (zero, 10 and 20%) (treatments 2, 3 and 4). Milk was concentrated at 55°C in a UF unit equipped with Carbosep mineral membranes, of 20 000 Daltons Molecular Weight cut off, at inlet and outlet pressure of 2.0 and 1.0 bar. Cheese was manufactured by the traditional process with enzymatic coagulation (Bela Vista Calf Rennet-90% chymosin) at 35°C/40 min., curd cutting, 20% whey withdrawal, direct curd cooking by hot water (80°C) addition, molding, pressing and curing at 7°C. Retentate portions were fermented up to pH 5.0 previously to coagulation. Experimental design was a random block with three replications. All four treatments presented a similar composition behavior and did not present a significant difference ($p>0.05$) for cheese protein recovery and yield. Fat cheese recovery was significantly smaller ($p<0.05$) for treatments 2 which is in agreement with the results obtained for adjusted yield, which also was significantly smaller ($p<0.05$) for treatment 2 but did not present significant differences among the other treatments. The results obtained indicated that UF M at the studied conditions did not present an advantage with respect to yield. However, this technique application can result in other advantages such as industry installed capacity maximization and economy with water consumption and effluent treatment.

Key Words: Cheese, Ultrafiltration, Yield

1016 Characterization of compositional and rheological properties of fresh cheeses made in the state of Chihuahua, Mexico. D. L. Van Hekken*[1], M. H. Tunick[1], F. J. Molina-Corral[2], J. E. Call[1], P. M. Tomasula[1], J. B. Luchansky[1], and A. A. Gardea[2], [1]*USDA, ARS, Eastern Regional Research Center, Wyndmoor, PA,* [2]*Centro de Investigacion en Alimentacion y Desarrollo, Cuauhtemoc, Mexico*.

The demand for Hispanic-style cheeses is increasing and an understanding of their basic quality characteristics is required in order to help manufacturers increase production and extend shelf-life. This study establishes the compositional and rheological characteristics of fresh cheeses made primarily by the Mennonite communities in Chihuahua, Mexico, from either raw or pasteurized milk. Samples of cheese were obtained within days of manufacture from 13 different producers (10 raw and 3 pasteurized milk cheeses). As expected, compositional and rheological properties of the fresh cheese varied among manufacturers. Overall compositional averages for the pasteurized and raw milk cheeses were similar; 31.3% fat, 24.4% protein, and 40.5% moisture. All cheeses tested negative for *Listeria monocytogenes*, *Escherichia coli* O157:H7, *Campylobacter* spp., and *Staphylococcus* enterotoxin. Aerobic and anaerobic microbial counts ranged from 3 to 8 $\log_{10}$ CFU/g for pasteurized milk cheese and 7 to 9 $\log_{10}$ CFU/g for raw milk cheese. Rheological data obtained from a Torsion Gelometer and a universal testing machine showed that the pasteurized cheeses tended to be harder, more rigid, and less springy than the raw milk cheeses. Viscoelastic properties obtained using a dynamic analyzer were similar for both types of cheese. Establishing the basic chemical, microbiological, and physical properties of Hispanic-style cheeses is the first step in understanding the unique quality traits and exploring ways to expand their utilization.

Key Words: Hispanic cheese, Raw milk, Rheology

1017 Effect of frozen storage on the proteolysis and rheology of soft goat milk cheese. D. L. Van Hekken*[1], M. H. Tunick[1], and Y. W. Park[2], [1]*USDA, ARS, Eastern Regional Research Center, Wyndmoor, PA,* [2]*Agricultural Research Station, Fort Valley State University, GA*.

Soft goat milk cheese is a highly valued dairy food with limited availability in the market due to the seasonal milk supply. Freshly-made cheese is frozen occasionally to extend the availability of the cheese, but it is not a wide spread practice because the effects of long term freezing on the texture and shelf-life of the cheese have not been evaluated. In this two year study, the effects of 3 mo of frozen storage on the degree of proteolysis and rheological properties of soft goat milk cheese were evaluated. Cheese was obtained from a grade A goat dairy in Georgia and either stored at 4°C for up to 4 wks or stored at -20°C for 12 wks and then thawed and stored at 4°C for up to 4 wks. Proteolysis was monitored using SDS-PAGE and rheological properties were measured using a universal testing machine and a dynamic analyzer. Paired fresh and frozen cheeses had the same degree of proteolysis (3 to 8% decrease in beta-casein) after 4 wks of refrigerated storage. Fresh cheese had a fragile texture and freezing for three mo did not result in major changes in texture, although the curds were slightly harder, less cohesive, and chewier than fresh cheese. Freezing did not alter the springiness or viscoelastic properties of the cheese Both fresh and frozen cheeses showed a decrease in cohesiveness after 4 wks of aging at 4°C. With the market for soft goat cheese increasing, freezing of the fresh curd could allow US goat producers to supply domestically manufactured soft cheeses throughout the year.

Key Words: Goat milk cheese, Frozen storage, Rheology

1018 Melt and color changes of heated Hispanic-style cheeses. D. W. Olson*, D. L. Van Hekken, and M. H. Tunick, *USDA, ARS, Eastern Regional Research Center, Wyndmoor, PA.*

Consumer interest in Hispanic-style cheeses is increasing, but functional property data that would assist the food processing industry in their utilization are limited. Hispanic-style cheeses are typically fresh cheeses with high moisture contents and a wide range of melting properties. The ability of various types of commercially available American-made Hispanic-style cheeses (Cotija, Oaxaca, Quesadilla, Queso Blanco, and Queso Fresco) to melt and their changes in color when heated were evaluated. Extent of melt was determined by the Schreiber Melt Test, which measures the spread of cheese after heating at 232°C for 5 min. Quesadilla and Oaxaca melted more than the other varieties. Queso Fresco and Queso Blanco had minimal melt. A Hunter Lab MiniScan XE was used to determine the L∗, a∗, and b∗ values of the cheeses before and after heating at 130°C for 75 min or 232°C for 5 min. The L∗ values before heating for Cotija, Queso Blanco, and Queso Fresco ranged from 85 to 94, and Oaxaca and Quesadilla ranged from 73 to 80 indicating that the former cheeses were whiter than the latter. More browning for each type of cheese occurred after heating to 130°C for 75 min compared to 232°C for 5 min leading to an increase in the a∗ values for the 130°C heat treatment and to a larger decrease in L∗ values for the 130°C compared to the 232°C heat treatment. As both melt and browning are related to specific production steps, procedures can be identified to alter undesired functional properties such as excessive browning. Understanding the melt and color changes of specific types of heated Hispanic-style cheeses helps the food processing industry in selecting the best type of cheese to give prepared foods the desired texture and appearance.

Key Words: Hispanic-Style Cheeses, Color, Melt

1019 Reversibility of pH-induced changes in the texture and serum phase of cultured cream cheese. M. Almena-Aliste*[1], M.L. Gigante[2], and P.S. Kindstedt[1], [1]*University of Vermont, Burlington VT/USA,* [2]*State University of Campinas, Campinas/SP/Brazil.*

Previously, a model system was developed to increase or decrease the pH of cream cheese through exposure to a volatile base or acid. Increasing the pH in this manner significantly decreased the firmness of cream cheese. The objectives of this study were to determine whether pH-induced changes in firmness are reversible when the pH is reversed, and whether the serum phase is affected by pH cycling. Cultured cream cheese was obtained from a commercial manufacturer within 10 d after manufacture. The cheese was sectioned into thin samples (10x40x65 mm) that were randomly exposed to ammonia vapor for periods ranging from 1 to 10 min to increase the pH in ten increments. After equilibration at 4°C for 3 d, the samples were analyzed for firmness and the amount and viscosity of expressible serum were determined. Next, specimens from the treatment with the highest pH value were randomly exposed to HCl vapor for periods ranging from 1 to 10 min to decrease the pH in ten increments. After equilibration at 4°C for 3 d, the samples were analyzed for firmness and the amount and viscosity of expressible serum were determined. The entire experiment was repeated twice. Firmness values decreased in a linear manner ($R > .90$) by $> 70\%$ with increasing pH from 4.6 to 6.1. Upon reversal of cheese pH, firmness increased in a linear manner ($R > .84$), displaying a high degree of reversibility. Amount of expressible serum decreased in a linear manner ($R > .84$) by $> 60\%$ with increasing pH from 4.6 to 6.1. Upon reversal of cheese pH, amount of expressible serum increased in a linear manner ($R > .83$), displaying a high degree of reversibility. Consequently, firmness and amount of expressible serum were strongly correlated ($R > .83$). In contrast, the viscosity of expressible serum was not affected by pH. The data are consistent with the view that the firmness of cream cheese decreased with increasing pH because of increased casein-water interactions which altered the mechanical properties of the casein-fat matrix of the cheese.

Key Words: Cream cheese, Texture, Serum phase

1020 Microstructure of Feta cheese made using different cultures as determined by confocal scanning laser microscopy. Ashraf Hassan*, Joseph Frank, and Milena Corredig, *The University of Georgia, Athens, GA, USA.*

The objective of this work was to develop a methodology to observe the microstructure of feta cheese using confocal scanning laser microscopy. Low fat cheese and cheese containing exopolysaccharide- producing cultures were made. The protein network was observed using the reflectance mode of the confocal microscopy. Fat was stained by Nile red dye diluted with whey obtained from the same batch of tested cheese. This procedure avoided soaking specimen in dye dissolved in distilled water (to prevent changes in osmolarity) or in lipophilic solvent (to avoid changes in fat size or shape). Capsule-forming slow acid producing and noncapsule-forming fast acid producing nonropy cultures were used in making nonfat and full fat feta cheese. More even distribution of fat with a larger number of smaller globules was observed in feta cheese made with noncapsule-forming culture compared to that made with the capsule-forming culture. A compact structure in nonfat cheese was associated with the use of noncapsule-forming culture which contrasted with the open structure observed in cheese made with the capsule-forming culture. Fractured structure was apparent after 10 days of storage of nonfat cheese made with the noncapsule-forming culture. Larger protein aggregates were observed in cheese made with capsule-forming culture compared to those found in cheese made with the noncapsule-forming culture.

Key Words: Feta cheese, Confocal scanning laser microscopy, Microstructure

1021 Effects of various ingredients on a model process cheese. A.L. Dees* and E.A. Foegeding, [1]*North Carolina State University.*

The process cheese industry desires to increase formula flexibility by incorporating various alternative ingredients into process cheese. For example, incorporation of whey protein ingredients could reduce the amount of casein used in process cheese formulations. The purpose of this study was to understand effects of various ingredients & how they affect texture and meltability of cheese. Among those studied were native whey protein, lactose, mono- and disodium phosphate, and polymerized whey protein concentrate (pWPC). Cheese analogs contained mono- and disodium phosphate, lactose and 1 of 4 different whey protein ingredients. Cheese analogs were made by heating & mixing for 21min in a Stephan mixer with end point temperatures of 80C or 85C. The pWPC was prepared by heating WPC at 90C, pH 8.0, for 30-60 min. Properties of pWPC were determined by viscosity measurements. Cheese analogs were characterized by yield stress and meltability measurements. Addition of lactose at 0% to 4.44% and mono- and disodium phosphate between 2% to 2.8% had no effect on the yield stress or meltability of cheese heated to 80C. Differences were observed when cheese was heated to an end point of 85C. The higher temperature increased yield stress 80% and reduced meltability from a Schreiber number of 9 to 5. These findings resulted in a final control formulation of 3.75% lactose and 2.8% emulsifying salts. Of three protein concentrations tested for polymerization, 5.0% protein had low viscosity, while 5.5% protein produced a texture similar to jelly. Generally, 6% protein formed a gel. Heating time varying between 30-60 min and sodium citrate varying between 0.5 - 1.0mM were not significant factors affecting viscosity of pWPC. All pWPC samples were pseudoplastic. A 13% substitution of casein with native WPC in a cheese analog resulted in no change in yield stress or meltability. Whereas a 13% substitution of casein with 5.5% protein pWPC in a cheese analog increased the yield stress 18% and decreased meltability to a Schreiber number of 10 to 8.

Key Words: process cheese analog, polymerized whey protein

1022 Comparison of shelf-life of fresh and frozen soft goat milk cheeses in relation to the extent of proteolytic and lipolytic properties. Y. W. Park*[1], A. Kalantari[1], V. Gutta[1], R. Gundelly[1], and J. H. Lee[1], [1]*Fort Valley State University, Fort Valley, GA 31030.*

Although freezing may extend storage life of cheeses, few reports are available on the feasibility of such practice on goat milk cheeses, especially for enhancing the year-round uniform supply and marketability of

the products. Three lots of fresh plain soft goat milk cheeses were purchased from a commercial grade A goat dairy, and divided them into two experimental groups. One group was stored as fresh at 4oC for 0, 14, and 28 days, and the other group was frozen for 3 months, then thawed, and stored at 4oC for 0, 14, and 28 days. The experiment was replicated three times, and pH, acid degree values (ADV), total protein and water soluble N (WSN) were determined for all treated samples to compare the shelf-life of the fresh with those of the frozen-stored cheeses with respect to the extents of proteolysis and lipolysis. The pHs for the overall pooled data of the fresh and frozen cheeses were; 4.57 and 4.88, respectively, indicating that cheeses aged as fresh had lower pHs than frozen-thawed ones. The overall pooled WSN contents of fresh and frozen cheeses were: 5.39 and 10.48, suggesting that there was a significant ($P<0.01$) increase in WSN for 3 month frozen-stored cheeses compared to the fresh ones. The respective WSN contents of fresh and frozen cheeses for the 0, 14, and 28 days of aging were: 2.97, 6.08, 7.11, and 9.61, 10.2, 11.6, showing that the frozen-storage significantly ($P<0.01$) elevated proteolysis of the cheeses. The ADV values of fresh and frozen cheeses for the corresponding aging periods were: 0.424, 0.545, 0.660, and 0.930, 0.757, 1.102, revealing that more lipolysis occurred in frozen-stored cheeses than fresh ones. The lipolysis was accelerated with time after 14 days storage at 4oC. The 3 months frozen-stored cheeses elevated proteolytic and lipolytic properties relative to the freshly stored ones, while further investigations may be necessary if these elevations are attributable to the freezing and thawing effect rather than frozen-storage.

Key Words: Soft goat cheese, Freezing, Storage

1023 Effect of pre fermentation of different portions of milk retentate on Prato cheese composition and melting capacity. J.R.F. Dornellas, L.M. Spadoti, C.R. Cunha, and S. Massaguer-Roig*, *Universidade Estadual de Campinas, Campinas, SP, BRASIL*.

Prato cheese, largely consumed in Brazil, it is a washed, semi cooked curd cheese similar to Gouda and Edam cheeses. Research on semi hard cheeses manufacture with milk ultrafiltration (M UF) has used partial concentration and pointed several advantages as well technological problems that can occur such as flavor and texture defects. Also has indicated that such defects can be minimized by means of pre fermentation of a portion of the retentate (R). The objective was to study the effect of pre fermentation of different portions of the R, with lactic starters, on chemical composition and melting capacity (MC) of prato cheese obtained by M UF with a volumetric concentration ratio of 3:1. Milk was concentrated at 55°C in a UF unit equipped with Carbosep mineral membranes of 20 000 Daltons MW cut off, at inlet and outlet pressure of 2.0 and 1.0 bar. Cheese manufactured by the traditional process with enzymatic coagulation (Bela Vista Rennet-90% chymosin) at 35°C/40min., curd cutting, 20% whey withdrawal, direct curd cooking by hot water (80°C) addition, molding, pressing and curing at 7°C. Experimental conditions consisted in fermentation of zero, 10 and 20% of the R up to pH 5.0 (treatments 2; 3 and 4) previously to coagulation and compared to a cheese manufactured with non UF milk (treatment 1). Cheeses were compared with respect to gross composition and MC. The pH and MC were evaluated during 45 days. Experimental design was a random block with three replications. All four treatments presented a similar composition behavior . The pH did not present significant changes ($p>0.05$) with respect to time, however treatments 1 and 2 presented higher pH when compared to treatments 3 and 4. All four treatmentes presented a significant increase ($pH<0.05$) on MC with respect to time. Treatments 3 and 4 presented a significant difference ($p<0.05$) among them and also with respect to treatments 1 and 2. Treatments 1 and 2 did not present significant difference ($p>0.05$) among them, being the MC of both significantly larger ($p<0.05$) than treatments 3 and 4 after 25 days of curing. Treatments 3 and 4 presented a pH always around or below 5.0 which seems to be the factor responsible for the observed difference on its MC.

Key Words: Cheese, Ultrafiltration, Melting

1024 Effect of post-manufacture modulation of cheese pH on the aging behavior of Mozzarella cheese. M.A.S. Cortez*[1], M.M. Furtado[1], M.L. Gigante[2], and P.S. Kindstedt[3], [1]*Federal University of Vicosa/CAPES, MG/Brazil,* [2]*State University of Campinas, Campinas, SP/Brazil,* [3]*University of Vermont, Burlington, VT/USA*.

Previously, a post-manufacture method to increase or decrease the pH of cheese was used to evaluate the effect of pH on characteristics of aged Mozzarella cheese. In those studies, the melting characteristics and calcium distribution of aged cultured Mozzarella cheeses changed rapidly (i.e., within 24 h) and dramatically in response to pH changes. The objective of the present study was to evaluate the effect of changing the pH of Mozzarella cheese immediately after manufacture on cheese characteristics during aging. On two separate occasions, cultured low moisture part-skim Mozzarella cheeses were obtained from a commercial manufacturer on the day after manufacture. The cheese was shredded, mixed and divided into subsamples that were exposed to either ammonia vapor to increase the pH by ca. 0.3 pH units, HCl vapor to decrease the pH by ca. 0.2 pH units, or no exposure (control). The subsamples were then vacuum packaged and stored at 4°C for up to 40 d. On day 5, 12, 22, and 40 after manufacture, control and treatment subsamples were chosen randomly and analyzed for apparent viscosity (AV), free oil, water soluble Ca and water soluble N. The effects of pH treatment, storage time and their interaction were evaluated by ANOVA according to a split-plot design. Apparent viscosity was affected significantly by pH treatment, storage time and their interaction. Cheese with increased pH had the highest AV values and cheese with decreased pH had the lowest AV values throughout the study. Water soluble Ca was significantly affected by pH treatment. Cheese with increased pH had the lowest water soluble Ca values and cheese with decreased pH had the highest water soluble Ca values throughout the study. Free oil and water soluble N increased significantly during storage but were not significantly affected by pH treatment. The data suggest that modulation of cheese pH immediately after manufacture caused a rapid shift in calcium distribution which altered the cheese structure and modulated the development of melting characteristics during aging.

Key Words: Mozzarella cheese, Calcium distribution, Functional characteristics

1025 Seasonal differences in the concentration of free amino acids and volatile compounds of Roncal cheese. Maria Ortigosa[1], Noemi Munoz[1], Paloma Torre[1], and Jesus M. Izco*[2], [1]*Dpto. Ciencias Medio Natural, Universidad Publica de Navarra, Spain,* [2]*Dairy Products Technology Center, Cal Poly University, San Luis Obispo, CA*.

The objective of this work is to identify the free amino acids (FAA) and volatile compounds in Roncal cheese throughout the entire campaign and to define any possible correlation or interaction between them. Roncal cheese is made in Navarra (Northern Spain) with raw, Lacha ewe's milk during the seasons of winter, spring and summer. It must be aged for at least four months before marketing. Cheeses with 4 and 8 months of ripening corresponding to the three seasons of the preparation period were sampled. Analysis of FAA was performed by HPLC and the volatile compounds were extracted by purge and trap and analyzed by GC-MS. Four month-cheeses made in summer showed higher concentration of total FAA (3319±11 mg/100g DM) than those made in winter or spring (2593±5 and 2340±9 mg/100g DM respectively). The major FAA quantified in Roncal cheese were Glu, Leu, Val, Lys, Phe, Pro and Ile, which accounted for 12.9, 10.2, 7.0, 6.7, 4.6, 3.9 and 3.0% of the total FAA, respectively. The volatile compounds present in Roncal cheese comprised 8 hydrocarbons, 13 alcohols, 2 aldehydes, 9 ketones, 6 acids, 5 esters, 3 sulfur-containing compounds and a miscellaneous group. Alcohols were the largest group, comprising the 21% of the volatile compounds identified in Roncal cheese. Accordingly, a total of 57 volatile compounds were detected. However, the number of compounds identified in cheeses with 8 months of ripening increased to 70. A positive correlation was found between some FAA and volatile compounds, e.g. the cheeses made in summer showed higher concentration of Val, Leu and Met, and therefore, of the alcohols formed by Strecker degradation of these amino acids (2-methylpropan-1-ol, 3-methylbutan-1-ol and propan-1-ol, respectively). Ethanol can be formed by degradation of Ala. However no correlation between the levels of these two compounds in the different seasons was found, probably because ethanol is formed primarily by fermentation of lactose. Valuable information to characterize Roncal cheese and the compounds affecting its flavor has been obtained in this work. Differences in its composition among the lactation periods of winter, spring and summer have been recorded.

Key Words: ewe's milk cheese, amino acids, volatile compounds

1026 Effect of frozen storage on microbial changes in soft goat milk cheese compared with fresh ones. A. Kalantari[1] and Y. Park*[1], [1]*Fort Valley State University, Fort Valley, GA 31030.*

Effect of 3 months frozen-storage on microbiological populations of commercial soft goat milk cheeses were compared with those of fresh ones in relation to the shelf-life of the products. Three lots of soft goat cheeses were purchased from a local farmstead grade A goat dairy, and divided into two treatment groups as fresh and frozen-stored groups. The fresh cheeses were placed at 4^oC refrigeration for 0, 14, and 28 days, and frozen cheeses were stored for three months, then thawed and placed in a refrigerator as the same way as the fresh ones. Microbial counts of total bacteria, E. coli and coliform, Staphylococcus aureus, and yeast and mold were assayed using 3M petrifilm plates techniques according to the manufacturer#s recommended procedures. Total bacterial cell counts (TBC) of the fresh and frozen goat cheeses for 0, 14, and 28 days storage at 4^oC were: 10.4, 1.91, 2.19 x 10^5, and 5.53, 0.296, 0.062 x 10^5, respectively, indicating that TBC was significantly ($P<0.01$) reduced by aging time and also by frozen-storage. The respective yeast counts of the fresh and frozen cheeses for the corresponding aging periods were: 14.1, 14.6, 30.7 x 10^5, and 0.03, 2.43, 0.876 x 10^5, showing that an opposite trend to TBC was observed in yeast count, where the latter counts were generally increased with aging time. There were no detectable levels of E. coli and coliform in both fresh and frozen cheeses, nor were found those of Staphylococcus aureus. Mold counts of the fresh cheeses significantly ($P<0.05$) decreased with storage at 4^oC, and frozen-storage also caused a significant reduction in mold count. It was concluded that freezing and/or frozen-storage for 3 months significantly reduced all microbiological populations tested, while lipolytic and proteolytic properties appeared to be elevated.

Key Words: Goat soft cheese, Microbiological counts, Frozen-storage

1027 Swiss cheese properties related to culture usage rate and warm room time . H. Ruiz-Espinosa, V.B. Alvarez, W.J. Harper, T. Ji*, and P.D. Courtney, *The Ohio State University.*

Swiss cheese manufacturing procedure was investigated. Small-scale rindless Swiss cheeses were made with different starter culture inoculation levels. *Streptococcus thermophilus* and *Lactobacillus helveticus* levels were 33%, 66% and 100% of recommended usage rate for commercial plants while the *Propionibacterium freundenreichii* subsp. *shermanii* inoculation level was kept constant at 100%. Cheeses were held for two different times in the warm room (WR). The cheeses were kept in WR at $25^\circ C$ for 14 and 21 days, and then ripened at $4^\circ C$ for 70 days. The cheese samples were analyzed for composition, pH, texture profile analysis, meltability, free amino acids, microbial growth and eye development. Different starter culture rates and WR times did not affect cheese composition. However, eye formation and pH were affected. The pH decreased as culture rates increased from 5.43 at 33% to 5.27 at 100% in WR for 14 days. Similar pH trends occurred in WR for 21 days. The culture rates and different WR treatments influenced to the growth of lactic acid bacteria and propionic acid bacteria. Cheeses processed with 100% culture rate for 21 days in WR liberated more free amino acids, an average equivalent value of leucine of 30.0 mmol/kg cheese, than the one for 14 days in WR. Overall results indicate that the effect of WR treatment time and culture usage rate did not affect small-scale cheesemaking significantly. Aging was the most significant source of variation on the analyzed parameters. The texture parameters, including hardness and cohesiveness tended to decrease, but cohesiveness, pH, meltability and free amino acids content increased during aging.

Key Words: Swiss cheese, Starter culture, Ripening time

1028 Use of starter cultures in milk of mexican white cheese. F. A. Rodríguez-Almeida*[1], R. Terrazas[1], H. García[1], O.M. Cano[1], J.A. Jimínez[1], and M.C. Olivas[2], [1]*Universidad Autónoma de Chihuahua, Chihuahua, México,* [2]*CBeta No. 90, Cd. Cuauhtémoc, Chihuahua, México.*

Three commercial starter cultures added to milk of mexican white cheese were compared to a control to evaluate their effects on organoleptic characteristics (38, 53 and 72 d after cheese processing) and on undesirable microbiological counts (36 and 71 d after cheese was made). Thirty liters of raw milk were used per piece of cheese, with three replicates per treatment (MA4001: *Streptococcus lactis, S. cremoris, S. lactis* subsp *diacetylactis* and *S. thermophilus*; MA011: *S. lactis* and *S. cremoris*; SACCO 0.19: *S. thermophilus* and *Lactobacillus lactis*; and control). Characteristics of milk were: acidity, 14 to 18^oD; fat, 4 to 4.6%; reductase, 10 to 12 h; mastitis and antibiotics, negative; density, 1.0295 to 1.0324; and total solids, 12.9 to 13.2%. Two to four days after cheese was processed, was packed into vacuum plastic bags for 38, 42 or 53 d. Microbiological counts were on total, presumptive and fecal coliforms, *E. coli, Staphylococcus aureus*, aerobic mesophyles, fungi and yeast. Panel tests were performed by 18 non-trained panelists that were familiar with mexican white cheese: one to evaluate general characteristics of cheese (flavor, texture, color and acceptance), and another one to evaluate similarities on flavor, texture and color to traditional mexican white cheese. Friedman#s non-parametric test was used for statistical analyses. Adding starter cultures to milk reduced microbiological counts at 36 d on total and presumptive coliforms ($p=.06$), and *S. aureus* ($p=.03$), compared to the control. All microbiological counts at 71 d were reduced ($p<.08$), except fungi and yeast ($p=.24$). At 36 d, MA4001 gave the best results, but at 71 d all starters gave similar results. At 38 d, MA4001 and MA011 were superior ($p=.001$) to SACCO 0.19 and the control for color; at 53 d were superior ($p=.01$) for all sensory variables, except texture ($p=.16$), which was accomplished by day 72 ($p=.08$). Adding starter cultures to milk of mexican white cheese resulted in improvement of organoleptic characteristics and reductions of undesirable microbiological counts on cheese.

Key Words: Starter Cultures, Organoleptic Characteristics, Mexican White Cheese

1029 Differentiation of cheese type and maturity: Comparison of a new SE-HPLC method with the RP-HPLC method. C. J. Coker[1], K. A. Johnston[1], R. A. Crawford[1], R. L. Motion[2], H. Singh[3], and L. K. Creamer*[1], [1]*New Zealand Dairy Research Institute, Palmerston North, NZ,* [2]*Forest Research Institute, Rotorua, New Zealand,* [3]*IFNHH, Massey University, Palmerston North, New Zealand.*

The unique character of most cheese types develops gradually during ripening and reflects the effect of manufacture and storage of the cheese on the quantity and activity of the enzymes present. The effect of these enzymes can be measured by analysing the resultant peptides, and these peptide profiles can differentiate cheese types objectively.

To date only RP-HPLC (a complex separation method relying on both peptide hydrophobicity and size) has been used successfully (Smith and Nakai, 1990) for this purpose. However, the peptide profiles contain a large number of peptide peaks that pose significant data-handling problems. Another method, SE-HPLC (TSK G2000 SWXL, 36% CH_3CN, 0.1% TFA in water) that separates on peptide size (molecular mass), has been successfully applied to protein hydrolysates and results in a simpler peptide profile.

In order to compare these two methods rigorously, three similar cheese types (Swiss, Elsberg and Gouda) were manufactured, ripened and sampled periodically. The water-soluble fraction from each sample was analysed by each method. The relationships among the peak areas were assessed by principal component analysis (PCA) using both the correlation and covariance matrices.

Analysis of the RP-HPLC data with PCA of covariance or correlation matrices differentiated cheese type using the first three principal components (PC1-PC3). However, maturity differentiation was only possible for young cheeses. Similar analysis of the SE-HPLC data was relatively simple and the covariance form of PCA differentiated the three cheese types at all stages of maturity using the PC1-PC3.

Thus, a combination of SE-HPLC of the WSF and PCA of the covariance matrix was the best of the methods investigated for differentiating similar cheese types at all stages of maturity and for assessing cheese maturity. The method was robust and it was relatively easy to obtain a data set for statistical analysis. By contrast, RP-HPLC of the WSF was more difficult to manage because of the large number of peaks with similar elution times. However, it had the advantage of indicating which peaks (peptides) were important in the assessment of cheese maturity or type.

Key Words: Cheese ripening, Principal component analysis, HPLC

1030 Use of dynamic rheological data for prediction of meltability of Gaziantep cheese with various fat contents. Talip Kahyaoglu*[1] and Sevim Kaya[1], [1]*University of Gaziantep*.

Gaziantep cheese is unripened and semi-hard cheese, which is produced traditional in the southeast part of Turkey. Meltability is an important functional characteristic of Gaziantep cheese due to its use as an ingredient in the traditionally prepared food. The objective of this study was to measure the meltability of Gaziantep cheeses containing various amount of fat. Dynamic rheological method and Arnott test were applied to evaluate meltability. Gaziantep cheese was manufactured with various levels of fat contents (50.4, 33.4, and 13.5 %). Meltability was assessed by an empirical method, Arnott test. For determination of dynamic rheological data, viscoelastic measurements were performed with a rheometer HAAKE RheoStress RS coupled with a Peltier/Plate TCP/P temperature control unit (HAAKE GmbH, Karlshure) using a cone and plate system (d:35 mm,α : 2°). Circulator DC10 was used to control temperature within range 10-70°C. The storage modulus (G'), loss modulus (G") and phase angle (δ) were measured during a temperature sweep varying from 10 to 70°C at a constant stress of 200 Pa and 1 Hz. For all samples, increasing temperature resulted in a decrease in G' and increase in the phase angle (phase lag) δ. Since tan (δ) = G"/G' when the G"=G', tan (δ) equals to 1.0. This means that solid and liquid characters are the same extent at this point is called as crossover temperature. This temperature might be accepted as the beginning of the melting. Melting temperatures were 56.1, 59.2, and 67°C for full-fat, reduced-fat and low-fat cheese, respectively. From the results of both methods, it was found that increasing the fat content decreased the melting temperatures. The good correlation was found between melting temperatures obtained by dynamic rheological data and meltability of Gaziantep cheese as determined by empirical melting test.

Key Words: Fat reduced cheese, Meltability, Dynamic rheological method

1031 Effect of high pressure treatment of Swiss cheese starter organisms on growth and activity in a sterile slurry system. W. J. Harper*[1], N. Akin[2], and G. Y. Kim[3], [1]*The Ohio State University, Columbus, Ohio,* [2]*Sekcuk University, Konya/Turkey,* [3]*Kangwon National University, Chunchon, Korea*.

Lactobillus helveticus and *Propionibacterium freundenreichii* in combination were treated at 0, 200, 500 and 800 MPa in an aqueous solution and then added to a sterile slurry system pre-acidified to pH 5.6 with lactic acid and ripened at 30 deg C. The slurries were evaluated at 0, 2, 4, 6. 8, 10 and 14 days for growth in selective media, free amino acid content and head space volatile compound differences at 0, 6 and 14 days with an electronic nose, using a Mass Spectrometer as the sensor system. Numbers of *Lb. helveticus* decreased by 3, > 4 and >4 log cycles after treatment at 200, 500 and 800 MPa respectively. Upon addition to the slurry, the Lb. helveticus showed recovery after 2, 4 and 4 days for the organisms treated at 200, 500 and 800 MPa respectively. A 4 log cycle increase in the slurry was noted after high pressure treatment in all cases. Numbers of *P. freundenreihcii* were not affected by the high pressure treatment. The increase in numbers after addition to the slurry system was greater for those organisms treated at 500 and 800 MPa than the control or the sample treated at 200 MPa. Free amino acids values increased during ripening at different rates depending upon treatment of the starter organisms. The initial rate of increase was greater during the first 6 days for the sample treated at 200 and 500 MPa, whereas the high free amino acid content was highest in the control after 14 days of incubation. Treatment at 800 Mpa resulted in a marked reduction in free amino acid values. Aroma, as detected by the electronic nose, was different among the slurries and each treatment showed a different aroma pattern during the incubation period. Cluster analysis showed 50% similarityamong all slurries. The slurries grouped into three clusters: (a) all slurries at 0 days, and 200 Mpa treatment at all days, (b) slurries made from the starter combination treated at 500 and 800 Mpa after 6 and 14 days of ripening and (c) the control starter combination after 6 and 14 days of ripening. Comparing 0 and 800 Mpa treatment, the slurries made with the starter combination treated with 800 Mpa treatment showed a higher abundance of those mass units that were most significant in differentiating the slurries.

Key Words: *Lactobacillus helveticus*, *Propionibacterium freundenreichii*, High pressure processing

1032 Lactic acid bacteria from natural biofilm of Tina, a wooden vat, potential contributors to Ragusano cheese fermentation. L. Corallo[1], P.S. Cocconcelli[2], R. Gelsomino[1], P. Campo[1], S. Carpino*[1], and G. Licitra[3], [1]*Consorzio Ricerca Filiera Lattiero- Casearia, Ragusa, Italy.,* [2]*Ist. di Microbiologia e Centro Ricerche Biotecnologiche, Université Cattolica, Piacenza e Cremona,* [3]*D.A.C.P.A., Catania University, 95100 Catania*.

The purpose of the present work is the study, by means of molecular techniques and electron microscopy analysis, of the bacterial strains composing the natural biofilm of Tina, and the investigation on release of bacterial cells from biofilm to milk during the first phase of Ragusano cheese production. The samples were collected from the inner surface of Tina (500 cm2) by means of sterile swabs. The Tina analysed in the course of the present work was used for processing milk collected from pasture feed cows and was used daily for milk fermentation and cheese production. Small pieces (4 mm ^{2}) of the internal wooden surface of Tina were collected using sterile blades and used for the electron microscopic analyses. Randomly selected colonies (300), of Gram positive, catalase negative organisms isolated from Rogosa and M17 agar plates, were cultured in MRS and M17 broth, respectively, incubated overnight at 30C. For bacterial cell release experiments from biofilm, the Tina was filled with sterile milk and gently mixed as generally performed during Ragusano cheese production. Samples (50ml) were collected after 15 and 90 min, serially diluted and plated on M17 5% lactose. Strain identification by means of RAPD typing was achieved as described by Baruzzi et al. (2000), with minor modifications. To achieve the taxonomic identification of the strains from Tina biofilm, the DNA was extracted as above described and 16 S rRNA genes were amplified using P1 and P6. The first aim of this study was to characterize the bacterial community on the inner surface of the Tina, a wooden vat used for the traditional production of Ragusano cheese. This microbiota undergoes cyclic changes of the environmental conditions: at the beginning of the production process raw milk is added in the vat, and after the addition of rennet maintained at 37C - 38C for 90 min. The presence of a significant amount of lactic cocci in the biofilm adhered to the inner wood surface of Tina was confirmed. The bacteria identified were Lactococcus lactis subsp. lactis, Streptococcus Thermophilus, Streptococcus Waius.

Key Words: Lactic bacteria, Ragusano cheese, wooden vat

1033 Impact of nisin producing culture, liposome-encapsulated nisin and *Lactobacillus casei*on Cheddar cheese ripening. R.-O. Benech*, E. Kheadr, C. Lacroix, and I. Fliss, *Centre de recherche STELA, Universite Laval*.

This study aimed to evaluate the effects of incorporating liposome-encapsulated nisin Z, nisin Z producing *Lactococcus lactis* subsp. *lactis* biovar. *diacetylactis* UL719, or *Lactobacillus casei-casei* L2A into cheese milk on textural, physicochemical and organoleptic attributes during ripening of Cheddar cheese. For this purpose, cheeses were made using a selected nisin tolerant cheese starter culture. A study of cheese proteolysis, free fatty acid production and rheological parameters was carried out during six months of ripening. Hydrophilic and hydrophobic peptides evolution during cheese aging was monitored using Reversed Phase-HPLC. Cheeses were organoleptically evaluated after six months. The results revealed that incorporating nisin-producing strain into cheese starter culture induced cheese proteolysis and lipolysis and had a little effect on cheese rheology. Moreover, production of hydrophilic and hydrophobic peptides was greater in this cheese than in control cheese and a bitter taste could be detected after six months ripening. Incorporating *Lb. casei* into cheese made with nisinogenic culture appeared to have a debittering effect and to improve cheese flavour quality. On the other hand, cheeses with added *Lb. casei* and liposome-encapsulated nisin Z exhibited the highest flavour intensity and ranked first for organoleptic characteristics.

Key Words: nisin Z, liposome, ripening

1034 Study of β-lactoglobulin-xanthan gum complexation by small-angle laser light scattering. S.I. Laneuville*[1], C. Sanchez[2], S.L. Turgeon[1], J. Hardy[2], and P. Paquin[1], [1]*Dairy Research Center STELA, Laval University, Quebec, Canada,* [2]*Institut National Polytechnique de Lorraine-ENSAIA, Vandoeuvre-lés-Nancy, France.*

The objective of this work was to determine the time evolution of β-lactoglobulin-xanthan gum (βlg-X) mixtures during electrostatic complexation under shearing (2000 rpm, laminar flow). Three βlg-X ratios were studied: 2:1, 5:1 and 15:1. The interaction was induced by adding glucono δ-lactone acid to obtain a final pH$\sim$4.5. The development of the emerging complexes was observed throughout acidification (every 60s for 15h) by small-angle static light scattering. Results were analyzed in terms of the time-evolution of the turbidity and of the scattered intensity I(q) in the q range 0.01-10.4μm^{-1}. Turbidity was used to determine the critical pH for soluble complexes formation (pHc) and for the development of intermolecular complexes that leads to macroscopic phase separation (pH$_\Phi$). pHc=5.74$\pm$0.02 was independent of βlg-X ratio, and since pHc>5.3 (the isoelectric pH of βlg) it could be inferred that the interaction started at charged patches on the protein surface. pH$_\Phi$ increased with βlg-X ratio from 5.11 to 5.43, indicating that at higher ratios, complexes were neutralized sooner since more protein was available for reaction. The evolution of I(q) showed that after an increase in the total number of particles, a cessation of domain growth occurred for ratios 2:1 and 5:1, probably due to the attainment of an electrostatic equilibrium in the mixture, which did not allow any further aggregation. For ratio 15:1 a second coarsening was observed in which large particles grew at the expenses of smaller ones possibly by flocculation or coalescence. The internal structure of the complexes was determined by measuring the cluster fractal dimension (d_f) from the slope at large q values with a I(q) $\sim q^{-df}$ power-law. The d_f evolution showed that loose and amorphous fractal structures were formed (d_f=1,8$\pm$0,1) which then reorganized into more compact complexes. This transition took place close to pH$_\Phi$ and may correspond to the isoelectric point of the complexes, where opposite charges are maximal and stronger interactions arise. Final d_f values increased with βlg-X ratio from 2.27 to 2.40. At higher ratios more protein is bonded to the xanthan molecule, due to mass action equilibrium, thus weaker interactions may occur allowing the protein to gradually rearrange into denser structures.

Key Words: Protein-polysaccharide interaction, Fractal dimension, Light scattering

1035 Emulsion stabilizing properties of chitosan in presence of whey protein isolate: effect of characteristics of chitosan and emulsification process. S. Laplante, S.L. Turgeon, and P. Paquin, *Dairy Research Center, Laval University.*

The stabilizing potential of 4 different chitosan preparations (CN) was compared in a model emulsion containing 0.5%(w/w) whey protein isolate (WPI) in 0.2M acetic acid (pH6.0), with 10%(v/v) canola oil. The main characteristics of CN were: CNI (78%DD, 1494KDa); CNHI (78%DD, 694KDa); CNHI2 (78%DD, 319KDa); and CNHK (68%DD, 749KDa). To verify the underlying mechanisms of interfacial stabilization (coadsorption of individual biopolymer species vs. adsorption of WPI-CN complex), we respectively compared the effect of a 2-step emulsification process (CN and WPI added sequentially before each homogeneization) with the 1-step with WPI/CN mixture. Emulsion stabilities were compared using turbidity (T) and droplet diameter (D) measurements at 0 and 21 days of setting at 21°C. Rheological parameters (yield stress (τo), consistency index (K), from Casson model) and droplet surface potential were also examined. Because 0.1% CN was the minimal requirement for effective emulsion stabilization, this condition was chosen for a more discriminative comparison of CN. The stability of lipid dispersion after 21 days, as revealed by T, followed this order: CNI > CNHK > CNHI > CNHI2 whereas D followed: CNI $\leq$ CNHI $\leq$ CNHK < CNHI2. Concerning rheological parameters, K remained comparable for all CN. However, τo increased in this order: CNI, CNHI < CNHI2 < CNHK, suggesting stronger droplet flocculation from CNHI to CNHI2. The highest τo observed for CNHK may be linked to chain entanglements, as D was comparable to CNHI emulsion. Finally, surface potential measurements of CN revealed positive zeta potential in the decreasing order: CNI, CNHI > CNHK > CNHI2. From those results, we conclude that stabilizing properties of CN are more affected by molecular weight (Mw) than by degree of deacetylation (%DD), the best stabilizing effect being obtained with CNI (highest Mw). However, the absence of significant effect from emulsification processes suggests that complexed as well as individual biopolymer species are responsible for interfacial emulsion stabilization.

Key Words: Chitosan , Emulsion, Stability

1036 Manufacture of hard "requeijao" cheese with reduced fat content using whey protein concentrate . F. M. Soares and L.M. Fonseca*, *University of Minas Gerais, Brazil.*

Hard "requeijao" is a traditional Brazilian cheese with high fat content. Basically, it is a cheese obtained as a result of heating a mixture of caseinate and cream, usually with addition of emulsifier salts, until the adequate texture is obtained. The objective of the present work was to elaborate a new technology for production of hard "requeijao", with reduced fat content. Whey protein concentrate (WPC), 80% protein, was used as a fat substitute in the "requeijao" made with 25% reduction in fat content, and was added at levels of 0.2%, 1.0% and 2.0% (wt. of WPC/wt.of caseinate and cream). These three different treatments were compared to a fourth treatment, that is, a control group with regular fat content. The hard "requeijao" was manufactured in industrial batches, and each treatment was repeated six times. The samples were analyzed in the first week of manufacture for composition, and an affective test with hedonic scale was applied after microbial testing of the product for fecal coliforms and Staphylococcus aureus, according to Brazilian legal requirements. The affective test with hedonic scaling was applied to at least thirty people for each time, and the results were submitted to an analysis of variance with comparison of means using Duncan test. Different treatments and repetition of batches were used as fixed factors. The results of composition showed that the only difference among the treatments and the control group was the fat content, with respectively, 27%, 19%, 20%, and 20% for the control group, treatment with 0.2% WPC, 1.0% WPC, and 2.0% WPC. The results of the sensory evaluation showed that, although there were no statistical differences between the treatments with fat reduction, only the treatment with addition of 1.0% WPC was statistically equal to the hard "requeijao" with regular fat content. The results show that it is feasible the manufacture of hard "requeijao" by using WPC as a fat substitute at level of 1.0%.

Key Words: Requijao, Whey Protein Concentrate, Reduced Fat

1037 Brazilian commercial pasteurized fluid milks flavor judging by the ADSA score card methodology. G.S.B. Aires and S. Massaguer-Roig*, *Universidade Estadual de Campinas, Campinas, SP, BRASIL.*

Flavor evaluation and criticism, of commercial pasteurized fluid milks samples, by the ADSA score card methodology (ADSA SCM) from some small and medium scale milk processors from Sao Paulo State, Brazil, and training of a group of undergraduate and graduate students as judges of milk evaluation by the ADSA SCM, to identify and grade flavor criticism in commercial milk samples were the objectives of this work. Forty commercial pasteurized milk samples, randomly collected at the retail outlets, and evaluated within their sell by date, from nine milk processors from Southeast State of Sao Paulo (Brazil) were flavor evaluated by the ADSA SCM. All milks were packaged in low density polyethylene plastic foil pouches, HTST plate heat exchanger pasteurized according to brazilian legal standards (72-75°C/15 to 20 sec.). According to brazilian law a Milk processing facility (MPF) can be a Micro MPF (McMPF) and a Mini MPF (MnMPF) which are interprises that process and packages up to 3000 l/day of fluid milk. McMPF only process it's own milk. Above 3000 l/day it is a MPF. Inspection can be Municipal (MI),State (SI) or Federal (FI). The nine processors were:one McMPF MI; one MnMPF MI; one MPF MI; one MnMPF SI; two MPF SI; three MPF FI. The commercial milk samples were sensorial evaluated during four consecutives weeks, two days a week and five different samples a day, by a 10 judges panel, trained by 18 consecutives weeks which consisted in recognizing and grading the flavor defects, and sample classification in basic categories; with prepared standard flavor defects using the ADSA SCM, according to Nelson & Trout (1964), Shipe et al. (1978) and Bodyfelt (1988). The panel was constituted by Food Engineering undergraduate students from CREUPI and Food Technology graduate students from UNICAMP. The main flavor defects were: 85 % flat flavor and 67,5 % light induced oxidized flavor. Most of the samples were classified as fair or poor , which reveals that although the commercial milks evaluated comply with sanitary, physical chemical, microbiological and

legal standards, more attention is needed from milk processors to milk flavor characteristics.

Key Words: Milk, Flavor, Defect

1038 The effect of milkfat on the sensory threshold of three impact odorants of strawberry flavor. S. Gaddamu, N. Slaughter, K. Adhikari*, and I. Gruen, *Department of Food Science, University of Missouri.*

The in-mouth release and subsequent perception of flavor compounds changes depending on the composition of the matrix, particularly fat content, because most flavor compounds are fat-soluble. The main objective of this study was to determine the effect of milkfat on the sensory threshold of three impact odorants of strawberry flavor. Dairy mixes containing either 4% or 10% milkfat, 5% sucrose and 10% milk solids-not-fat were used as the experimental matrices to determine the threshold of ethyl-3-methyl-3-phenylglycidate, α-ionone and *cis*-3-hexenol. A paired difference test was performed using a panel of 22 judges to find threshold values of the three compounds. Seven concentration levels of each compound were paired with blanks. The order of serving was randomized within each pair and also among the concentration levels. Two replicates were carried out for each compound. Results were analyzed by plotting % correct response (y-axis) against the concentration of the compounds (x-axis). A logistic regression model (sigmoidal curve) was used for curve fitting and the concentration value corresponding to 66.7% correct response was calculated. The threshold concentrations for ethyl-3-methyl-3-phenylglycidate, α-ionone and *cis*-3-hexenol, were 360, 680 and 500 ppb, respectively, for the 4% fat mixes. For the 10% fat mixes, these values were 460, 600 and 190 ppb, respectively. The higher threshold concentration for the water-insoluble, aromatic ethyl-3-methyl-3-phenylglycidate in the 10% fat mix indicates a slower release at higher fat levels, and is explainable by the greater affinity to the lipid phase in the dairy mixes. While α-ionone is also an aromatic compound, it is slightly more water-soluble than ethyl-3-methyl-3-phenylglycidate and showed a slightly slower release in the 4% fat mix, although the difference was not very large. The higher threshold concentration of *cis*-3-hexenol, an aliphatic compound, which is slightly soluble in water, in the 4% fat mix indicates a slower release compared to the 10% fat mix. Chemical analyses will be performed to determine the solubility and the liquid-air partition coefficients of these flavor compounds in 4% and 10% fat emulsions to correlate to the results of the sensory threshold test.

Key Words: strawberry flavor, threshold, milkfat

1039 Odor profile of typical Sicilian cheeses: Maiorchino, Pecorino, Provola dei Nebrodi and Ricotta infornata. S. Mallia[1], S. Carpino*[1], E. Lavin[2], G. Di Rosa[1], G. Licitra[3], and T.E. Acree[2], [1]*Consorzio Ricerca Filiera Lattiero Casearia, 97100 Ragusa, Italy,* [2]*Cornell University, Geneva, NY 14853,* [3]*D.A.C.P.A., Catania University, 95100 Catania, Italy.*

Odor-active volatiles present in cheese products may be important markers of both cheese quality and diversity. Developing methods to identify odor-active compounds and evaluate their sensory impact on artisanal cheeses will impact both quality control and authentication protocols for these cheese products. In this study, the aroma volatile profiles of four native Sicilian artisanal cheeses were assayed using Headspace Solid Phase Microextraction (HSPME) and Gas Chromatography Olfactometry (GCO) dilution analysis (Charm analysis) (Acree et al., 1984), in order to identify the odor-active compounds in the cheeses and to rank their relative odor potencies. Selected compounds with high potency were subsequently quantified in the cheese headspace using HSPME GC/MS calibrated to SPME (Deibler, 2001), static headspace and solvent injected standards. Maiorchino, Pecorino, Provola dei Nebrodi and Ricotta infornata cheeses were studied. Thirty-one different odors were detected in the cheeses by GCO analysis with 26 of these identified by GC/MS, published retention index matches (FlavorNET, Arn & Acree, 1998) and running authentic standards. SPME dilution analysis found ethyl hexanoate, ethyl butyrate, (E)-2-nonenal, methional, 1-octen-3-one, 2-nonanone, dimethyl disulfide, dimethyl trisulfide, nonanal and butyric acid as having the highest odor-potencies in the cheeses. Butyric and acetic acids were the only FVFA's to produce odor responses in GCO analyses. Pecorino and Maiorchino cheeses were found to have the most diversified odor profiles, which included the odor-active terpenoids α-pinene, sabinene, linalool, L-carvone, citronellol and geranyl acetate. These terpenoids were not found in the Provola dei Nebrodi and Ricotta infornata cheeses. Selected compounds from the list of most potent odorants were quantified via headspace analysis.

Key Words: Sicilian Cheese, HPSPME, GCO

1040 Effect of the utilization of an adjunct starter culture on the volatile compounds and sensory characteristics of a Spanish raw ewes' milk cheese. Maria Ortigosa[1], Jesus M. Izco*[2], Cristina Arizcun[1], and Paloma Torre[1], [1]*Dpto. Ciencias Medio Natural, Universidad Publica de Navarra, Spain,* [2]*Dairy Products Technology Center, Cal Poly University, San Luis Obispo, CA.*

The aim of this work is to evaluate the effect caused by the utilization of an adjunct starter culture on the volatile compounds and sensory characteristics of an ewes' milk cheese. Three cheese batches were made, one with raw milk (batch C), another with pasteurized milk (batch P), and a third with pasteurized milk in which an added adjunct starter culture (*Lb. casei* + *Lb. Plantarum*) in addition to the commercial starter was utilized (batch F). Cheese was made according to the protocol for Roncal cheese with Denomination of Origin. Cheeses were sampled at 1, 120 and 240 days of ripening. The volatile components were extracted by purge and trap and analyzed by GC-MS. Cheeses aged for 120 and 240 days underwent sensory analysis by a panel of at least eight expert assessors. Eighty-six components belonging to the following chemical families were identified: hydrocarbons, fatty acids, esters, sulfur-containing compounds, ketones, aldehydes, and especially alcohols. Pasteurization decreased the quantity of some alcohols, aldehydes and ketones. Trimethylpyrazine increased in cheese made with pasteurized milk. Pyrazines formed by the heat treatment have been related to chocolate and coffee flavors in cheese. In fact, cheese P obtained higher number of sensory perceptions of this sensory descriptor grouping than the rest. Significant differences ($p<0.05$) for characteristic odor, aroma and flavor were recorded between 4 month-cheeses from batches C and P. However, 8 month-cheeses from batches C and F showed similar scores between them and higher than those obtained by batch P. This could be caused by higher concentration of some acids (2-metyl propanoic and 3-methyl butanoic) and esters (methanoic acid, methyl ester; methanoic acid, butyl ester and heptanoic acid, ethyl ester) in C and F. Pasteurization of milk has influenced the concentration of certain volatile compounds, affecting adversely the characteristic flavor of cheese. However, the utilization of *Lb. casei* + *Lb. Plantarum* as adjunct starter culture in addition to the commercial starter improves the flavor when using pasteurized milk to make this kind of cheese.

Key Words: ewe's milk cheese, volatile components, adjunt starter culture

Food Safety

1041 The use of immunoaffinity columns for the isolation of ractopamine from edible tissues of food animals. W. L. Shelver* and D. J. Smith, *USDA/ARS/Biosciences Research Laboratory, Fargo, ND.*

Ractopamine (Paylean^{TM}) (RAC) is a beta-adrenergic leanness-enhancing agent recently approved for use in finishing swine. The currently available determinative method for RAC in tissues employs a lengthy cleanup procedure. Our objective was to determine the utility of a RAC immunoaffinity column (IAC) as a simple cleanup method for RAC in muscle, liver, and kidney. RAC and ractopamine glucuronide (RAC-G) fortified tissues were homogenized in phosphate buffered saline (pH 7.2), passed through a 1-mL RAC IAC, and the IAC washed with 10% methanol to remove non-bound material. RAC and RAC-G were eluted with 50 mM glycine, pH 2.8. Recoveries of RAC and RAC-G from cattle muscle, liver, and kidney were 82.1 7.6, 87.8 1.9, and 92.5 0.4 %, respectively (n=3). Recoveries of RAC and RAC-G from sheep muscle, liver, and kidney were 91.8 0.2, 91.7 0.3, and 92.7 0.6 % respectively (n=3). Subsequent HPLC with florescence detection indicated that IAC