

## Dairy Foods: Dairy Products and Processing I

**TH18 Stability of a long life drinking yoghurt.** M. M. Macchione and W. H. Viotto\*, *State University of Campinas, Campinas, SP, Brazil.*

Heat treatment of yoghurt after fermentation may extend its shelf-life, but proteins may become instable because of the heating in low pH. This work studied the effect of 2 different post-fermentation heat treatments (72°C/15s and 110°C/15s) and 2 storage temperatures (5–7°C and 25–30°C) on the physicochemical and microbiological properties of drinking yoghurt stabilized by pectin. Skim milk with 12% sugar was heated at 80°C/30min and 2% EPS producing starter culture (mix of *Streptococcus thermophilus* and *Lactobacillus bulgaricus*: Yo-Mix™ 601 Lyo from Danisco™ Brazil) was added at 45°C, until reaching pH 4.0. Pectin (0.45% of Grindsted™ Pectin AMD 382, from Danisco™ Brazil) was added with 2% sugar and the yoghurt was treated in a tubular heat-exchanger followed by aseptic homogenization. The product stability was evaluated during 95 days, by following analyses: pH and titratable acidity; sedimentation and syneresis (by centrifugation); apparent viscosity (Brookfield rheometer), standard plate count (PCA), lactic acid bacteria (MRS) and yeasts and moulds (PDA plus antibiotics). Heat treatment intensities and storage conditions did not affect the products stability, and no physical changes occurred during all the storage time. The only parameter affected was the viscosity, which was lower for the most intensive treatment (25cp x 35cp) and increased under refrigerated conditions (3–5cp) for both treatments. There were no changes in acidity (1.1% lactic acid), pH (3.9), sedimentation (2–3%) and syneresis (none) due to the type of heat treatments and storage temperature and time. All the heat treatments resulted in stable products, with no microbiological growth during the 95 days of storage. Maximum standard plate count was 25 CFU/ml and no detectable amounts of yeasts and moulds were found.

**Key Words:** Drinking Yoghurt, Long Life, Stability

**TH19 Thirty-four percent whey (WPC) and serum protein (SPC) concentrate and 65% serum protein (SP) reduced micellar casein: production and composition.** J. Zulewska<sup>\*1</sup>, D. M. Barbano<sup>2</sup>, M. W. Newbold<sup>2</sup>, M. A. Drake<sup>3</sup>, E. A. Foegeding<sup>3</sup>, and C. Moraru<sup>2</sup>, <sup>1</sup>*University of Warmia and Mazury, Olsztyn, Poland*, <sup>2</sup>*Cornell University, Ithaca, NY*, <sup>3</sup>*North Carolina State University, Raleigh.*

Raw whole milk (ca. 1200 kg) was split into two portions. One portion was pasteurized and made into Cheddar cheese and whey and the other was cold separated into skim milk (SM) and cream. The SM was pasteurized and microfiltered (MF) at 50°C with a 0.1 micron ceramic uniform transmembrane pressure system to produce a 65% SP reduced micellar casein concentrate (MCC) and MF permeate. The separated whey and MF permeate were ultrafiltered (UF) to produce liquid 34% WPC and SPC. This was replicated 3 times. No difference in UF flux when processing whey or MF permeate from skim milk using a spiral wound 10 kDa polyethersulfone membrane was detected after 60 min of processing, 15.7 vs. 14.6 kg/m<sup>2</sup>/h. The liquid WPC was opaque while the SPC was clear and the pH of the liquid WPC was lower than the WPC, 6.44 vs. 6.74. Half of the MCC, WPC, and SPC was spray dried, moisture 3.8, 3.0, and 4.1%, respectively and the other half was freeze dried, moisture 3.3, 2.5 and 3.1%, respectively. The protein content of

WPC and SPC powders (total nitrogen × 6.38) were 34.5 and 35.3% on a dry basis, respectively. Spray dried WPC contained more fat on a dry basis than SPC, 1.94 vs. 0.25%, and this may cause flavor or flavor stability differences. The WPC contained more glycomacropeptide than SPC (4.1 vs. 0% of protein) and this may cause differences in functionality. The WPC and SPC contained phosphorus, calcium, magnesium, potassium, sulfur, and sodium at the following percentages on a dry basis: 0.63 and 0.56, 0.57 and 0.44, 0.12 and 0.11, 1.91 and 1.88, 0.52 and 0.57, and 0.45 and 0.43, respectively. WPC contained significantly higher content of calcium and phosphorus than SPC, which may influence functionality. No differences in L, a, b color values were detected for the spray dried WPC and SPC at 90.25 and 90.05, -0.42 and -0.50, and 6.40 and 5.90, respectively. The spray dried 65% SP reduced MCC contained 2.3% fat and 57.9% protein on a dry basis.

**Key Words:** Whey and Serum Protein Concentrate, Production, Composition

**TH20 Comparison of sensory and functional properties of 34% serum (SPC) and 34% whey protein concentrates (WPC).** J. P. Evans<sup>\*1</sup>, P. J. Luck<sup>1</sup>, E. A. Foegeding<sup>1</sup>, J. Zulewska<sup>3</sup>, D. M. Barbano<sup>2</sup>, and M. A. Drake<sup>1</sup>, <sup>1</sup>*North Carolina State University, Raleigh*, <sup>2</sup>*Cornell University, Ithaca, NY*, <sup>3</sup>*University of Warmia and Mazury, Olsztyn, Poland.*

Serum proteins (SP) are primarily  $\alpha$ -lactalbumin and  $\beta$ -lactoglobulin removed directly from skim milk while these same proteins for WPC manufacture are typically harvested from whey after cheese making. Since SP are not exposed to the cheese make-process, enzymatic and/or chemical reactions that can lead to off-flavors, or a reduction in functionality, are reduced. Research today has not compared flavor and functionality of SPC and traditional WPC. SPC and WPC (34%) were manufactured in triplicate from the same lot of milk. At each replication, liquid SPC and WPC were collected and spray-dried (SD) and freeze-dried (FD). Solubility, heat stability, gelation and foaming properties were measured. A trained sensory panel documented the sensory profiles of liquid retentate and rehydrated spray or freeze-dried powders. Volatile components were extracted by solid phase micro-extraction (SPME) followed by gas chromatography-mass spectrometry. Both SPC and WPC were characterized by low intensities of sweet aromatic and cardboard flavors, but these intensities were lower in SPC compared to WPC. Diacetyl flavor was absent in SPC. SD increased flavor intensities compared to FD, but the types of flavors documented were not different. Volatile compound results were consistent with sensory results. All SPC treatments were more soluble and had generally lower turbidity than their corresponding WPC treatment. In addition, all SPC treatments exhibited greater foaming properties than corresponding WPC treatments. No stable foams were generated from liquid or freeze-dried WPC treatments, and spray-dried WPC produced foams low in yield stress, overrun and stability. SPC treatments were also more heat stable and produced stronger gels than similar WPC treatments. These results indicate that 34% SPC has distinct differences in functional and flavor characteristics from WPC.

**Key Words:** Whey Protein, Serum Protein, Flavor

**TH21 The effect of crosslinked  $\beta$ -cyclodextrin treatment on the rheological and sensory properties of ice cream.** H. J. Ha\* and H. S. Kwak, *Sejong University, Seoul, Korea.*

This study was designed to examine the effect of crosslinked  $\beta$ -cyclodextrin ( $\beta$ -CD) treatment on cholesterol removal, and the rheological and sensory properties of ice cream when stored at 4, -12, -18 and -28°C. Cholesterol-reduced milk and cream were made by crosslinked  $\beta$ -CD. Ice cream mixes were formulated with 15% milk fat, 8% nonfat milk solids, 1.3% sugar and 0.3% stabilizer. Then it was pasteurized at 65°C for 30 min, homogenized in a single-stage homogenizer at 10.4 MPa and cooled to 4°C before tests were performed. The cholesterol removal reached 90.3% when crosslinked  $\beta$ -CD was treated. Ice crystal size was greater in the control at 4 and -28°C storage temperature, however, it was smaller at -12 and -18°C storage temperature. The viscosity of the cholesterol-reduced ice cream was significantly lower at all temperatures than that in the control. In addition, the viscosities in both groups were significantly higher at -18°C storage temperature compared with other temperatures. The meltdown stability appeared to be lowered with the crosslinked  $\beta$ -CD treatment in all storage temperatures. Most of color values were different between the control and the cholesterol-reduced ice cream. The L-value was increased in the melted state than in the frozen state in all temperatures, whereas a-value was decreased. Appearance of the cholesterol-reduced ice cream was similar to the control, however, it was decreased at -28°C storage temperature. In addition, the overall acceptability was lower in both groups at -28°C storage temperature. The present study indicated that the crosslinked  $\beta$ -CD treatment showed the lower viscosity and meltdown stability, however, sensory characteristics were not significantly lowered compared with the control.

**Key Words:** Ice Cream, Viscosity, Meltdown Stability

**TH22 Rapid determination of emulsifier and stabilizer concentration in ice cream.** S. L. Cropper\*, N. A. Kocaoglu-Vurma, L. E. Rodriguez-Saona, and W. J. Harper, *The Ohio State University, Columbus.*

Ice cream is a complex foam structure consisting of fat, sweeteners, flavorings and air incorporated during the freezing process. Emulsifiers and stabilizers are used to help stabilize the air within the fat matrix producing a better quality product. Fourier Transform Infrared Spectroscopy (FTIR) has shown to be a rapid and effective method for analyzing and determining ingredient concentrations in ice cream.

The objective for this research was to generate a multivariate calibration model using infrared spectroscopy to quantify stabilizer and emulsifier concentrations in ice cream.

Ice creams were made with 10% fat, 11% milk solids non-fat, 18% sugar and varying concentrations of mono and diglycerides (MDG) and carboxy methyl cellulose (CMC) ranging from 0.0-0.15 % for MDG and 0.0 to 0.20 % for CMC. All ingredients were blended and the mix was homogenized, pasteurized, and aged at 4°C for two days. Following aging, the mixes were frozen using a scraped surface heat exchanger at -4°C and then stored at -40°C. Each ice cream was thawed and 0.5 $\mu$ L was placed directly onto the ZnSe-ATR crystal, vacuum dried to produce a thin film, and the spectra, which was collected in the mid-IR region (4000-700 cm<sup>-1</sup>), was analyzed using partial least squares regression (PLSR) analysis.

Multivariate models (PLSR) for emulsifier (MDG) and stabilizer (CMC) were developed from infrared spectra (770-1800 and 2800-3005 cm<sup>-1</sup>),

resulting in a correlation coefficient of validation ( $r_{Val}$ )  $\geq$  0.92 and a standard error of validation (SEV) of 0.01% for estimation of emulsifier and stabilizer levels.

Infrared spectroscopy can estimate MDG and CMC in the ice cream individually and in combination within the complete ice cream matrix. This method provides an efficient way to analyze emulsifier and stabilizer concentrations in ice cream and offers a faster means of quantification of ingredients. Infrared spectroscopy can be used to better understand the combined roles of emulsifiers and stabilizers in the ice cream system. Overall, this technique allows for easier monitoring of ice cream quality during processing and will enable the manufacturer to minimize production cost while ensuring the highest quality.

**Key Words:** FTIR, Ice Cream

**TH23 Addition of rice extract improves the quality characteristics and consumer acceptability of banana flavored yogurt.** T. Bor\*, D. Song, C. W. Seo, and S. A. Ibrahim, *North Carolina A&T State University, Greensboro.*

Manufacturing dairy products with consistent and desirable textures continue to be a concern to the industry. Different approaches have been studied recently to improve texture ranging from using different process techniques to different ingredients. Rice possesses some unique properties that may be of interest to the dairy industry. Rice is rich in oligosaccharides, hydrocolloids compounds that could be used to improve the texture of dairy products. The objective of this study was to evaluate the effects of rice extract on the quality characteristics and consumer acceptability of banana flavored yogurt. Rice flour (10% wt/vol) was cooked with tap water for 45 min and stored at 4 C for 2 days to allow for gel formation. Plain yogurt was purchased from a local store and mixed with rice extract at 5% (wt/wt, rice extract/ yogurt). Sliced fresh banana (2% wt/wt) was then mixed with the yogurt mix. The finished product was stored in the refrigerator for 12 h before conducting the sensory evaluation. A consumer panel recruited from the university campus (n= 90) rated the acceptability and sensory characteristics of the products. In addition, pH values, apparent viscosity, color and water holding capacity of the yogurt samples were recorded. Results showed that panelists gave high acceptability scores for yogurt with rice flour samples in term of texture, appearance and overall acceptability. The addition of rice flour did not change the pH value of the yogurt. The viscosity, color and water holding capacity measurements were slightly changed with the addition of rice flour. These findings suggest that rice extract can be added to improve the quality characteristics and consumer acceptability of banana flavored yogurt. Moreover, since rice and banana flavored products are popular among ethnic groups including Asians and Hispanics, the use of this food combination of has promising market potential.

**Key Words:** Yogurt, Rice

**TH24 Functional properties of 65% serum protein reduced micellar casein concentrates obtained by microfiltration.** C. M. Belicium<sup>1</sup>, J. Zulewska<sup>2</sup>, M. Newbold<sup>1</sup>, C. I. Moraru<sup>\*1</sup>, and D. M. Barbano<sup>1</sup>, <sup>1</sup>*Cornel University, Ithaca, NY*, <sup>2</sup>*University of Warmia and Mazury, Olsztyn, Poland.*

The objective of this work was to characterize the functional properties of micellar casein concentrates (MCC) obtained by microfiltration

(MF). 65% serum protein (SP) reduced MCC was obtained by MF of skim milk in a uniform transmembrane pressure system equipped with a 0.1 micron ceramic membrane. The MF retentate (MCC) was both spray dried (3.8% m.c.) and freeze dried (3.3% m.c.). The spray dried 65% SP reduced MCC contained 57.9% protein (d.b.) and 2.3% fat. Solubility, emulsification and foaming properties of the MCC powders were determined. The rheological properties of the MCC liquid retentate and of reconstituted MCC powders were also measured. The powder solubility was the property mostly affected by the drying method. The sediment for freeze dried MCC ranged between 0.25±0.00 mL and 1.58±0.14 mL among 3 replicates, and for spray dried MCC between 5.83±0.58 mL and 8.67±0.29 mL. The foam expansion was higher for spray dried (212.9%) as compared to freeze dried MCC (151.1%); foam stability was poor for all samples. No significant differences in emulsification properties between spray and freeze dried MCC were observed, with emulsification stability values of 69.73±2.17% and 65.98±1.09%, respectively. Low amplitude rheological measurements of reconstituted MCC of 7.5% to 15% concentration showed slightly higher values of the storage modulus ( $G'$ ) for spray dried as compared to freeze dried MCC. The fresh retentates had lower  $G'$  and  $G''$  than the reconstituted samples, at the same concentration, due to denaturation of residual SP in the dried samples. No significant differences in apparent viscosity, yield stress and flow index were observed between different batches or drying methods. Viscosity and yield stress increased with concentration. At the same concentration, fresh retentates were more viscous than reconstituted samples, due to the denaturation of SP in the MCC powders. Flow indices decreased with increasing concentration, indicating a tendency towards shear thinning behavior of the concentrated MCC. Fresh retentates had a flow behavior closer to Newtonian than reconstituted MCC, due to the native state of proteins.

**Key Words:** Micellar Casein, Functionality

**TH25 Surface hydrophobicity of co-extruded and milled corn starch with whey protein concentrate as a function of pH.** S. L. Amaya-Llano\*<sup>1,2</sup>, E. Castano-Tostado<sup>2</sup>, F. Martinez-Bustos<sup>1</sup>, and L. Ozimek<sup>3</sup>, <sup>1</sup>*Ciencia de Materiales, CINVESTAV Queretaro, Queretaro, Mexico*, <sup>2</sup>*PROPAC, Universidad Autonoma de Queretaro, Queretaro, Queretaro, Mexico*, <sup>3</sup>*University of Alberta, Edmonton, AB, Canada*.

The aim of this work was to study the effect of co-extrusion over blends of corn starch and WPC measuring surface hydrophobicity. Surface hydrophobicity (SH) was used to define the potential interaction between starch and protein at varied technological parameters of extrusion such as temperature, moisture and hydrogen ion concentration. The extrusion factors were: barrel temperature (70-180°C), feed moisture (18-30%), pH (3-8), different proportions of corn starch (75-95%), and whey protein concentrate (WPC, 80% protein concentration) (25-5%). The extrusion process was carried out using a single screw extruder, designed and manufactured by Cinvestav-IPN, Mexico. The screw compression ratio was 1:1 with a 5.0-mm die-nozzle. The co-extruded product was milled to particle size below 250 µm. This milled product can be used as a new food ingredient as source of protein, as stabilizer or emulsifier. In order to define suitable food applications of the new ingredient, functional properties must be determined. Surface hydrophobicity is a good indicator of the ingredient hydrophobic sides available for interaction in food systems. Also, the SH was used in this study to probe interaction between corn starch and WPC during extrusion process. Results showed

that SH is affected by processing parameters of extrusion and it can be used to monitor the interaction between proteins and carbohydrates.

**Key Words:** Surface Hydrophobicity, Extrusion, Whey Protein Concentrate

**TH26 Effect of ultrasound treatment on microbial load in milk.** S. Gokavi, T. Silk, and M. Guo\*, *University of Vermont, Burlington*.

Non-thermal technologies such as ultrasound are emerging as promising alternatives to heat treatment for food processing. Ultrasound is defined as sound waves with a frequency greater than 20 kHz that are able to travel through gas, liquid and solid materials with proven bactericidal effects, especially when combined with mild heat treatments. The objective of the present study was to determine the effect of ultrasound treatment on standard plate count levels (SPC) present in raw milk and non-pathogenic *Escherichia coli* and *Listeria innocua* inoculated in ultra-high temperature (UHT) milk. An ultrasonic processor (VCF 1500HV, Sonics & Materials, Inc., CT) consisting of a continuous flow cell and a 10" titanium alloy probe (Frequency 20 kHz, 100% power level, 650 W acoustic power, 132 W/cm<sup>2</sup> acoustic intensity) with a 370 ml sample processing chamber was used. Samples were subjected to two treatments: batch and continuous flow (420 ml/min) at two temperatures 25±2° and 55±2°C with treatment times of 6, 12, 18 and 24 min. Both batch and continuous treatment at 25±2°C for 24 min yielded a 3-log reduction of SPC, a 3-log reduction of *E. coli* and 1 to 2-log reduction of *L. innocua*. Ultrasound treatment with mild heat (55±2°C) was effective at reducing SPC in raw milk. Reductions were also noted in *E. coli* and *L. innocua* levels inoculated in UHT milk. Batch ultrasound treatment combined with mild heat for 24 min yielded a 5-log reduction of SPC, a 4-log reduction of *E. coli* and 3-log reduction of *L. innocua*. Continuous flow ultrasound treatment combined with mild heat for 24 min resulted in a 6-log reduction of SPC, a 6-log reduction in *E. coli* and *L. innocua*. Inactivation regressions were second-order polynomials, showing an initial period of rapid inactivation, eventually tailing off. Results indicate that ultrasound technology is a promising processing alternative for the reduction of microbial load in milk and other liquid foods.

**Key Words:** Milk, Ultrasound Treatment, Microbial Load

**TH27 Effects of high pressure homogenization on milk.** C. A. Boeneke\*, A. Pastorek, and K. J. Aryana, *Louisiana State University Agricultural Center, Baton Rouge*.

Homogenization is a process of forcing milk through tiny orifices. The resulting pressure causes the fat globules to become smaller limiting their separation in the emulsion. Although effective, some separation of the fat can still occur over time. As demand for dairy products with longer shelf lives i.e., products processed using Ultra High Temperature and Ultra Temperature pasteurization grows, separation of the fat is a concern. In this experiment, milk was standardized to 2% and 3.25% fat before homogenization at 50, 125, and 200 MPa using an APV 2000 two stage homogenizer (APV Systems Albertslund, Denmark) to determine effects of increased homogenization pressure on the finished product. Milk was collected and stored at 7 °C for 3 weeks. Milks were analyzed for fat content, rate of creaming, viscosity and color. Milk was evaluated for flavor, body/texture, and appearance/color at the end of 1, 2, and 3

weeks of storage by a 5 member trained panel. Trained panelists were unable to detect differences in flavor, appearance/color, or mouth-feel over a three week period. Homogenization was affected by pressure, inlet temperature, and fat content of the milk. No creaming was observed over a two week storage period. Changing milk inlet temperature and homogenization pressures influenced results.

**Key Words:** Milk, High Pressure Homogenization

**TH28 Classification of cream butter by infrared spectroscopy and multivariate analysis.** S. Herringshaw\*, N. Kocaoglu-Vurma, and L. Rodriguez-Saona, *The Ohio State University, Columbus.*

Food authenticity has become a focal point attracting the attention of producers, consumers, and policy makers. Major authenticity issues concern the true labeling of food whereby substitution of high value raw materials with cheaper materials is common practice. Factors such as milk sources and production methods result in a wide range of butter types, some of which command a premium price. There is a need for rapid and reliable analytical tools for determination of authenticity since traditional methods often involve time-consuming and laborious processes. Our objective was to evaluate the application of infrared spectroscopy combined with pattern recognition techniques to discriminate among butter samples in relation to quality and authenticity. Butter produced by different manufacturers from different production lots were purchased from a local market (Columbus, OH). Samples were filtered at 65°C and the collected fat samples were directly applied onto a temperature-controlled single bounce ZnSe crystal for attenuated total reflectance measurements. The ZnSe crystal was heated at 65°C and spectra analyzed using soft independent modeling of class analogy (SIMCA), a multivariate classification technique. This simple protocol generated unique mid-infrared signature profiles that permitted the chemically-based classification of butter samples based on manufacturer. By using the spectral region from 1200-900 cm<sup>-1</sup>, multivariate (SIMCA) modeling showed well-separated clusters that discriminated among butter samples, due to -HC=CH- trans bending out of plane vibration modes (968 cm<sup>-1</sup>) presumably attributed to conjugated fatty acids. Infrared spectroscopy combined with multivariate analysis provides a simple and efficient tool for classification of butter with minimal sample preparation. This rapid protocol can provide both the industry and regulatory agencies with markers by which butter can be classified and whereby uniform quality can be established thus providing a tool for determining butter authenticity.

**Key Words:** Butter, Authenticity, Infrared Spectroscopy

**TH29 Effect of various antioxidants on the characteristics of plain yogurt.** B. Brignac<sup>1</sup> and K. Aryana\*<sup>2</sup>, <sup>1</sup>*Louisiana State University, Baton Rouge*, <sup>2</sup>*Louisiana State University Agricultural Center, Baton Rouge.*

Free radicals have a significant influence on ageing and age-related conditions. Optimal intake of antioxidant nutrients may contribute to enhanced quality of life and may delay / slow the onset of ageing. The objective was to study the effect of vitamin C, vitamin E, beta carotene and a combination of these three antioxidants on the characteristics of plain yogurt. The antioxidants Vitamin C, vitamin E and beta carotene

and a combination of Vitamin C + vitamin E + beta carotene were incorporated at 100% of their respective recommended dietary allowance of 60 mg, 10 mg and 3 mg and 60 + 10 + 3 mgs respectively in an 8 oz cup of yogurt. Product manufacture was replicated three times. Flavor scores for yogurts with vit E and yogurts with beta carotene were high and not significantly ( $p < 0.05$ ) different from each other. Flavor scores for yogurts with vit E were significantly ( $p < 0.05$ ) higher than the control. Yogurts with vit C + vit E + beta carotene had flavor scores that were not different from control but were significantly ( $p < 0.05$ ) lower than yogurts with vit E and beta carotene. Control yogurts and yogurts with vit C and yogurts with vit E had significantly ( $p < 0.05$ ) high appearance scores which were not significantly ( $p < 0.05$ ) different from each other but were significantly ( $p < 0.05$ ) higher than yogurts with vit C + vit E + beta carotene. Yogurts with vit C + vit E + beta carotene had the lowest appearance scores. Yogurt with vit E had higher body and texture scores compared to the control while yogurts with vit C has lower scores compared to the control. The remaining yogurts had body and texture scores not significantly ( $p < 0.05$ ) different compared to the control. Yogurts with vit C + vit E + beta carotene had the highest a\* values compared to the remaining yogurts which were not significantly ( $p < 0.05$ ) different from each other. Compared to control there were no significant ( $p < 0.05$ ) differences in pH, apparent viscosity, lactobacilli counts, L\* and b\* values of yogurts with antioxidants. Use of antioxidants influenced some characteristics of plain yogurt.

**Key Words:** Yogurt, Antioxidant, Quality

**TH30 Effect of stabilizer and emulsifier concentrations on particle size and melting rate of ice cream.** S. L. Cropper\*, N. A. Kocaoglu-Vurma, and W. J. Harper, *The Ohio State University, Columbus.*

Stabilizers and emulsifiers are used in ice cream to improve texture and maintain structure. Emulsifiers help to minimize the coalescence of fat and destabilize the fat globule in the matrix. Stabilizers are commonly utilized for their ability to bind water in ice cream, but also have been found to play a part in enhancing fat aggregation. Determining how particle size and melting rate is influenced by stabilizer and emulsifier concentration is beneficial to see what the maximum quantities of these ingredients are required to provide the best texture.

The objective for this research was to determine the influence of varying emulsifier and stabilizer concentrations on particle size and melt rate of ice cream.

Ice cream mixes were prepared with 10% fat, 11% milk solids non-fat, 18% sugar and varying concentrations of mono and diglycerides (MDG) and carboxy methyl cellulose (CMC) ranging from 0.0-0.15 % for MDG and 0.0 to 0.20 % for CMC. All ingredients were blended and the mix was homogenized, pasteurized, and aged at 4°C for two days. After aging, the mixes were frozen using a scraped surface heat exchanger to -4°C and then stored at -40°C. Each type of ice cream was evaluated for particle size, d [4, 3] (volume-surface weight diameter), using a particle size analyzer and the melting rate by a melt test, which determined sample weight loss at ambient temperatures over time.

Particle size analysis showed, for samples containing MDG only, d [4, 3] values to be significantly higher at concentrations  $\geq 0.09\%$ . The d [4, 3] values for samples containing 0.05% and 0.10% CMC were significantly higher than the control when CMC concentrations were varied at set MDG concentrations of 0.075% or 0.15%. The melting rates were not significantly different at any of the tested concentrations.

The results show that the effect of stabilizers and emulsifiers on particle

size is concentration dependent. Using the proper amounts of stabilizers and emulsifiers in ice cream is important in order to produce a higher quality product that is more desirable to consumers.

**Key Words:** Melt Test, Particle Size, Ice Cream

**TH31 Fluctuation on composition and insoluble aggregates in a WPC manufacturing line: Implications for quality and function.** M. Costa<sup>2,1</sup>, M. Gigante<sup>2</sup>, P. Tong<sup>1</sup>, and R. Jimenez-Flores\*<sup>1</sup>, <sup>1</sup>California Polytechnic State University, San Luis Obispo, <sup>2</sup>UNICAMP, Campinas-Sao Paulo, Brazil.

In response to quality demands of users and producers of whey protein powders, we have investigated the basic influence that composition has upon processing of liquid whey into WPC in a commercial plant. Several researchers indicate either the formation of 'aggregates' or the difference in particle size in the whey concentrates, as the main causative agents of quality and functionality variation. However, very few studies have thoroughly analyzed the fundamental origin or causes for the variability of whey powders in a systematic and holistic way. This work is an initial step to gather base-line information on the range of variability in particle size and composition of the liquid whey protein concentrate (LWPC) and the resulting powder (WPC80) in a commercial plant. Our study was carried out for a period of 8 weeks in a plant that process in excess of 10 million pounds of milk per day. Due to security and sanitation aspects, employees of the plant did the sampling. Upon receipt each sample was divided and 15ml of the LWPC sample were frozen for later composition analyses (protein, fat, lactose, ash, total solids). For each set of sample, we prepared 5% protein solutions with the WPC and LWPC, which were stirred for 1 hour and analyzed in the same (LWPC) or in the following day (WPC). Particle size and Solubility were measured for each sample. All samples were analyzed for total composition. The results indicate that while protein concentrations are maintained within a narrow range, lactose and residual fat have the highest ranges of variation. During our study the liquid concentrate had an average of 20.22 ( $\pm 0.97$ ) % protein, while lactose was 1.06 ( $\pm 0.58$ ) and residual fat 1.35 ( $\pm 0.19$ ); for the WPC protein was 78.78 ( $\pm 0.72$ ), lactose 7.94 ( $\pm 1.12$ ) and residual fat 5.66 ( $\pm 0.53$ ). Particle size analysis resulted in Volume %: liquid concentrate solutions had no particle larger than 20 $\mu$ m (the LWPC were stored in a cooler until be analyzed; results could varied when heated), while the WPC solutions in average had around 27% of the particles in the over 20 $\mu$ m range, so mean and mode parameters had higher values in the WPC solutions. Our analysis of the proteins by SDS-PAGE indicates that the aggregates have a very complex composition that is not correlated with only insoluble b-LG. Our results seem to point towards differences in minerals and residual fat, as primary causative agents of particle size fluctuations in WPC manufacture. As for processing, Ca, pH and temperature along processing are major aggregate-inducing factors.

**Key Words:** Whey Protein Concentrate, Protein, Insoluble Aggregates

**TH32 Influence of pulsed electric field processing on protease activity of *Lactobacillus acidophilus* LA-K in skim milk.** O. Cueva<sup>1</sup> and K. Aryana\*<sup>2</sup>, <sup>1</sup>Louisiana State University, Baton Rouge, <sup>2</sup>Louisiana State University Agricultural Center, Baton Rouge.

The objective was to study the effect of square waveform bipolar pulse widths on protease activity of *Lactobacillus acidophilus* LA-K. Freshly thawed *Lactobacillus acidophilus* LA-K was suspended at 1% wt/v in 0.1% wt/v peptone and was treated in an OSU-4 pilot plant pulsed electric field (PEF) processor. The processing conditions that remained constant were field strength of 25 Kv/cm, pulse period of 10000 us, delay time of 20  $\mu$ s and processing temperature of 21°C. The treatments were square waveform bipolar pulse widths of 0, 3, 6 and 9  $\mu$ s. Immediately after passing through the PEF processor the *Lactobacillus acidophilus* LA-K cell suspension was used to inoculate skim milk followed by incubation at 40°C. After 0, 12 and 24 h of incubation, protease activity in control and all treatments was evaluated by the *o*-phthalaldehyde (OPA) assay followed by absorbance measurements using a spectrophotometer set at 340 nm. The pulse width x incubation time interaction effect was significant ( $P < 0.0001$ ). The maximum absorbance values were recorded for samples treated for 6  $\mu$ s and incubated for 24 hours (mean  $\pm$  SD) ( $0.45 \pm 0.003$ ) followed by 9  $\mu$ s for 24 h ( $0.43 \pm 0.004$ ), followed by 3  $\mu$ s for 24 h ( $0.35 \pm 0.002$ ) followed by the control ( $0.35 \pm 0.006$  absorbance units). A different trend was seen for the samples incubated for 12 h. Samples treated for 9  $\mu$ s showed maximum absorbance values ( $0.32 \pm 0.006$ ) followed by 6  $\mu$ s ( $0.25 \pm 0.003$ ) followed by 3  $\mu$ s ( $0.240 \pm 0.000$ ) followed by the control ( $0.213 \pm 0.000$  absorbance units). For a 24 h incubation, samples processed at 6  $\mu$ s pulse width gave the maximum protease activity, while for a 12 h incubation, samples processed at 9  $\mu$ s pulse width showed maximum protease activity.

**Key Words:** Pulse Width, Non Thermal, Processing

**TH33 Production of native whey from whole milk.** I. Jarto\*<sup>1</sup>, J. A. Lucey<sup>1</sup>, D. Zhu<sup>1</sup>, and K. E. Smith<sup>2</sup>, <sup>1</sup>University of Wisconsin, Madison, <sup>2</sup>Wisconsin Center for Dairy Research, Madison, WI.

The objective of the study was to investigate the viability of using whole milk (WM) as a starting material to produce native whey protein by spiral-wound microfiltration (MF). A single commercial scale 0.3  $\mu$ m polyvinylidene fluoride spiral-wound element was used. Pasteurized skim milk (SM) or pasteurized non-homogenized WM with an initial volume of 230 kg was microfiltered at either 4 or 13°C with inlet and outlet pressures of 120-135 kPa and 42-75 kPa, respectively. The milk was microfiltered to a volume concentration factor (VCF) of 3 with an hour of batch recirculation at VCF of 1, 2, and 3. Operating conditions and flux were recorded over time. Permeate and retentate samples were collected for compositional analysis. A Malvern Mastersizer was utilized to evaluate the fat globule size distribution before and after MF processing. MF performance was evaluated as a function of permeate flux rate and whey protein transmission over VCF of 1 to 3. At 4°C, lower MF flux was observed for WM compared to SM, particularly at higher VCF (probably due to increased viscosity of WM). During MF at 4°C, the average ratios of WM permeate flux to SM permeate flux at VCF 1, 2, and 3 were 0.98, 0.87, and 0.31, respectively. However, at 13°C the flux in WM was more comparable to SM, with average ratios of WM permeate flux to SM permeate flux at VCF 1, 2, and 3 of 1.00, 0.98, and 0.74, respectively. Fat globule size distribution was not altered by the MF processing in any trial. During MF at 4°C, the whey protein concentration in permeates at VCF 1, 2, and 3 were 0.09%, 0.13%, and 0.23% for SM and 0.09%, 0.16%, and 0.35% for WM, respectively. During MF at 13°C, the whey protein concentration in permeates at VCF 1, 2, and 3 were 0.06%, 0.12%, and 0.21% for SM and 0.05%, 0.11%, and 0.25% for WM, respectively. Our study concluded that native whey proteins can be separated successfully at low temperatures from WM

using spiral-wound MF membranes at rates comparable with the whey protein permeation rate in SM.

**Key Words:** Whole Milk, Microfiltration, Native Whey Protein

**TH34 Flavor assessments of heated sweet cream butter.** E. L. Harvey\*, A. M. Renaud, and S. A. Rankin, *University of Wisconsin, Madison*.

Butter contains numerous compounds capable of reacting during the course of extended heat treatment such as baking or frying. The objective of this work was to determine the effect of heat treatment on the volatile character of unsalted sweet cream butter using instrumental and sensory methods. This work reports the qualitative presence of volatile compounds generated by extended heat treatment of butter. Pasteurized (87.2°C, 19s) 37% milkfat cream was churned to invert the emulsion. After draining the buttermilk, the fresh butter was analyzed for the presence of volatile compounds using GC/MS with SPME (DVD/

Carboxen/PDMS fiber). The butter was placed in a glass vial with Teflon-lined closure and rapidly heated to by immersion in a mineral oil bath. The heated samples were analyzed using GC/MS and SPME as above, and the results were compared with those of the fresh butter. The fresh sample contained numerous volatiles including short chain free fatty acids (butanoic acid, hexanoic acid, octanoic acid, nonanoic acid, and decanoic acid). Aldehydes and ketones were also found including hexanal, nonanal, 2-heptanone, and nonanone. The lactones  $\delta$ -hexanolactone,  $\delta$ -octalactone, and  $\delta$ -decalactone, and one sulfur compound dimethyl sulfone occurred in both samples. The heated samples contained increases in the number of volatile compounds including lipid oxidation and Maillard reaction products. Partially trained descriptive panel assessments demonstrated relationships between heating and several sensory descriptors. This work provides a rapid method for the assessment of heated butter volatiles as well as describing the influence of thermal treatment on sensory character. Applications of this work may be used by processors to optimize flavor contributions resulting from heat treatment of butter.

**Key Words:** Heated Butter, Solid-Phase Microextraction, Sensory Analysis