W142 Improved heat stability of whey protein isolate by dry-heating with inulin. Yue He and Bongkosh Vardhanabhuti*, *University of Missouri, Columbia, MO.*

Dry-heating whey protein with reducing saccharides via Maillard reaction has been shown to improve heat stability. Selecting proper saccharides that offer technological and nutritional benefits could create new protein ingredients that have better functional properties and are more attractive to the consumers. The aim of this study was to develop heat stable whey protein ingredients by dry-heating with inulin, a non-digestible carbohydrate with known health and technological benefits. The effects of biopolymer ratio and heating conditions on heat stability, physicochemical properties, and nutritional qualities of the conjugates were determined. Whey protein isolate (WPI) and inulin at weight ratios of 1:1 to 6:1 were dissolved in deionized water, freeze-dried, and incubated at 70 to 80°C for 12 – 72 h without or with controlled relative humidity (RH) at 44 or 80%. Heat stability was measured by heating 6% w/w protein solutions, pH 6.0 at 85°C for 15 min and the absorbance was measured at 630 nm. Particle size, zeta potential, rheological properties, and lysine content were determined. WPI or mixed WPI-inulin (no dry-heating) turned very opaque after heating. Dry-heating of WPI-inulin clearly increased heat stability as shown by a significant reduction ($P < 0.05$) in turbidity (e.g., from A630 of 1.9 for WPI control to 0.8 for 12 h dry-heated 6:1 WPI-inulin) and particle size (from 160 nm in z-average diameter to 107 nm). Decreasing WPI:inulin weight ratio and increasing dry-heating temperature, incubation time, as well as RH resulted in increased heat stability; however, brown color intensity also increased. Rheological analysis revealed that all samples maintained Newtonian behavior with no significant difference in flow behavior index and consistency index. Dry-heated WPI-inulin had higher surface charge compared with WPI. The loss of lysine content ranged from 2.6% in 6:1 WPI-inulin after 12 h dry-heating to 19.2% in 2:1 WPI-inulin after 72 h dry-heating. In conclusion, dry-heating WPI with inulin creates new ingredient with improved heat stability. The new ingredient has great potential to be used in high protein beverages or other applications that require heat stability.

Key Words: whey protein, inulin, heat stability

W143 Heat treatment effect on hydrolysis of sodium tripolyphosphate in milk. Diogo Maus, Alviclér Magalhães, and Walkiria Hanada Viotto*, *University of Campinas (UNICAMP), Campinas, São Paulo, Brazil.*

Sodium phosphate salts are widely used in the manufacture of processed cheese for the stabilization of casein, as well as to improve the texture and functionality of the final cheese. The essential role involves calcium sequestering and pH control leading to the hydration and dispersion of casein, which in turn allows it to act as emulsifying agent resulting in the formation of a homogeneous cheese structure. During the processing phosphates may undergo hydrolysis due to heat treatment, pH and ionic environment. The formation of short chain phosphates increases the buffering capacity of the medium and therefore affects the final pH of the processed cheese. The objective of this study was to investigate the impact of temperature on the hydrolysis of sodium tripolyphosphate (STPP) in milk. Milk with 2.3% STPP was heated to 90°C and cooled to 5°C and the nuclear magnetic resonance (NMR) spectra were obtained at 5°C intervals. ^{31}P NMR spectroscopy was performed using a double resonance probe, fitted with a field gradient in the Z direction, coupled to a Bruker AVANCE III, operating at 14.1 T static magnetic field (500 MHz for ^{1}H). The spectra were processed with the aid of TOPSPIN 3.1 software. STPP hydrolysis occurred for the entire temperature range during milk heating and cooling and was significantly more intense from 80°C. At 90°C, 20.5% of STPP was hydrolyzed resulting in a 33.5% increase in the amount of pyrophosphate and orthophosphate. The spectra also showed a shift from left to right, indicating that the STPP hydrolysis resulted in a more acidic environment, which can affect the rate of hydrolysis. Knowledge of the phosphates behavior during processing can lead to a better understanding of the changes associated with the protein matrix of processed cheeses and its functional properties. Acknowledgment: São Paulo Research Foundation (FAPESP), grant 14/07291–3.

Key Words: phosphate, hydrolysis, NMR

W144 Inactivation of thermoduric sporeformers in milk by continuous ultrasonication. Dikshi Bawa*, Sanjeev Anand, and Steve Beckman, *South Dakota State University, Brookings, SD.*

Thermoduric sporeformers can survive milk pasteurization and cause spoilage in dairy foods. Our previous studies established that batch ultrasonication combined with pasteurization inactivated thermally resistant vegetative cells of spore forming *Bacillus* spp. This study investigates the effect of a continuous ultrasonication process to reduce thermoduric sporeforming bacilli in milk. We hypothesize that ultrasonication causes increase of cell membrane permeability leading to leakage of cell components thus causing cell death. Mid exponential phase vegetative cells of thermoduric *Bacillus coagulans* (ATCC 12245) were inoculated in sterile skim milk at log 5 cfu/mL. Their thermal stability was validated by exposing them to batch pasteurization (63°C for 30 min). Inoculated skim milk was passed through a continuous ultrasonicator with 22-mm sonotrode, 20 kHz frequency, and 1000 W power input (UIP1000hd, Hielscher USA, Inc.), at 86% (91.2 µm) amplitude and a flow rate of approximately 7.5 L/h and back pressure of 345 kPa resulting in an exposure time of 80 s per pass. Ultrasonicated samples were batch pasteurized to study the combined effect. Brain Heart Infusion agar was used for plating the survivors. Experiments were conducted as replicates of 2, and were repeated thrice. Statistical significance of the data was determined using SAS enterprise guide 7.1 software. A significant ($P < 0.05$) reduction was found in the log counts after treatments. Lab pasteurization alone reduced the vegetative cells by 25%, while ultrasonication alone resulted in a greater inactivation of 92% after 12 passes (16 min total exposure time). Inactivation was further increased to 99.98% by combining ultrasonication and pasteurization. It can thus be concluded that a continuous ultrasonication process followed by pasteurization is highly effective to inactivate thermoduric vegetative cells of sporeformers such as *Bacillus coagulans.*

Key Words: ultrasonication, pasteurization, thermoduric sporeformer

W145 Effect of ultrasound treatment on reconstituted deproteinized whey prior to lactose crystallization. Steve Beckman, Lee Alexander*, Sanjeev Anand, and Lloyd Metzger, *South Dakota State University, Brookings, SD.*

Ultrasonication (US) is an emerging technology being applied to dairy streams. The objective of this study was to determine the effect of US on reconstituted deproteinized whey (DPW) before crystallization and

isolation of lactose. Commercial DPW was reconstituted to 65% TS (wt/wt) at 80°C. Solutions were then seeded (0.027 g/100 g solution) with lactose crystals, or treated with US (10 min, 22.5 Hz) and then seeded. Each sample was then stirred for one min and transferred into a 1 L glass crystallizer (CST). The CST was immersed into a temperature controlled bath and cooled from 80 to 18°C (rate = −0.0479°C/min). Constant agitation (100 rpm) was applied to the CST by an overhead stirrer and agitator. After crystallization, approx. 225 g of solution was transferred to a centrifuge bottle. The solution was centrifuged at 10,000 × *g* for 30 min at 5°C. The supernatant was decanted, weighed, and a mass of deionized water (<4.0°C) equivalent to the supernatant was added to resuspend the crystals before centrifugation. The resuspended crystals were centrifuged, decanted, and resuspended 3 more times using the previous procedure (4 washes total). Recovered lactose crystals (>75 crystals) were measured microscopically (10×) to determine mean crystal size. Total solids of commingled supernatants, and of isolated crystals were measured to assess yield. Each treatment was repeated in triplicate. Mean crystal size, and lactose yield data were analyzed for statistical significance with replicate and treatment as categorical explanatory variables. Mean crystal size was larger ($P < 0.01$) for the US treatment, 85.0 µm, than for the control treatment, 74.4 µm. Lactose yields, 78.7 and 78.9%, for control and US, respectively, were not different ($P > 0.05$). Theoretical yield for lactose at the conditions used is 88%. Yields may be overestimated due to non-lactose impurities. Ultrasonication with seeding of reconstituted DPW before crystallization increased lactose crystal size, but did not increase lactose yield.

Key Words: lactose, crystallization, ultrasound

W146 Evaluation of a Centritherm evaporator for concentrating micellar casein. Anil Kommineni, Dustin Grossbier*, Steven Beckman, Ananya C. Biswas, and Lloyd E. Metzger, *Midwest Dairy Foods Research Center, Dairy Science Department, South Dakota State University, Brookings, SD.*

Micellar casein is produced by micro-filtering skim milk. In a typical skim milk microfiltration (MF) process the retentate produced has approximately 10% protein and 12% total solids. After MF this retentate can be further concentrated before spray drying. In previous research we determined that micellar casein could be concentrated to approximately 25% solids using a falling film vacuum evaporator. However, concentration beyond 25% solids was challenging due to the high water binding and film forming characteristics of micellar casein. As compared with falling film evaporation, a Centritherm evaporator (CTE) is a thin film vacuum evaporator that can be used to concentrate highly viscous products. In a CTE the feed tube distributes product on the underside of a rotating heating cone through a feed nozzle. Steam is injected on the opposite side of the cone thereby heating the product stream through conduction. Centrifugal force of the rotating cone creates a thin, turbulent layer, which gives a residence time of 1sec with a high heat transfer coefficient. The objective of this study was to evaluate the CTE for concentrating micellar casein. In this study, 3 replicates of micellar casein with 12% solids were manufactured by micro filtration of skim milk and then used as feed for the CTE. Initial trails were conducted to find the optimum evaporation conditions for minimal fouling. The heating temperature of 80°C, boiling temperature of 50°C and feed rate of 50 L/h were determined as optimal. Each replicate of micellar casein was passed through the CTE 3 times. The average water evaporation rate in each pass and the total solids of the concentrate was determined. The total solids content of the final micellar casein for each replicate was 22.49, 21.92, and 22.93%. The mean water evaporation of each pass was 6.17, 5.92, and 3.83% respectively for pass one, 2, and 3. The decreasing water evaporation rate with each pass may be a result of increased water binding as the solids content of the micellar casein increased. The results indicate that the CTE concentrated micellar casein similar to falling film evaporation.

Key Words: micellar casein, Centritherm evaporator

W147 Novel microfiltration process for the manufacture of soluble casein isolate from acidified milk. Yanjie Lu*, Michael Molitor, and John Lucey, *Wisconsin Center for Dairy Research, University of Wisconsin-Madison, Madison, WI.*

Caseinates are traditionally manufactured by precipitating caseins using acid, thoroughly washing the precipitate and then neutralizing the casein curd with alkali, which requires very specialized equipment. The objective of this study was to develop an innovative process utilizing spiral filtration to produce a soluble casein product that would act as a caseinate alternative. Stable casein dispersions were prepared by sufficient acidification of pasteurized skim milk to solubilize the colloidal calcium phosphate (CCP), but avoid aggregating the caseins. The acidified skim milk was processed at ambient temperature using microfiltration /diafiltration to remove serum proteins, lactose, and the soluble minerals. Next the soluble casein product was neutralized with 40% NaOH and spray dried. Compositional analysis, SDS-PAGE, and turbidity measurement were used to characterize the casein product. Our results showed that acidification to pH ~5.3 solubilized the majority of CCP and allowed the removal of calcium during membrane processing. Acidification of the diafiltration water helped to maintain the narrow target pH range throughout the extensive diafiltration. The microfiltration process, temperature and pH were all optimized to promote casein retention and avoid temperature and /or pH-induced casein aggregation. The casein isolate powder had ~93% of crude protein (dry basis), 0.08% calcium, 0.37% lactose, 1.60% fat and casein accounted for 97% of the crude protein. When rehydrated to a total solids content of 5% (w/v), our casein product was less turbid compared with commercial sodium caseinate. This novel process looks promising for the production of a soluble casein product.

Key Words: caseinate, membrane filtration, acidification

W148 Effect of some operating parameters on the hydraulic resistance developed during milk protein concentration by ultrafiltration. Stephanie Methot-Hains*, Alain Doyen, Laurent Bazinet, and Yves Pouliot, *STELA Dairy Research Center, Institute of Nutrition and Functional Foods, Université Laval, Québec, Canada.*

Milk protein concentrates are increasingly used as enrichment ingredients in cheese manufacturing. Ultrafiltration (UF) membranes with a molecular weight cut-off of 10 kDa are typically used for concentrating skim milk proteins content up to 57 to 84% (dry basis). However, some operating parameters such as transmembrane pressure control, temperature or multistage design have important impacts on process efficiency and functional properties of the concentrates. The objective of this work was to investigate the effect of transmembrane pressure (TMP) on the membrane performance and the protein retention by UF on skim milk using a 10 kDa polyethersulfone membrane. Skim milk was concentrated by a 4X volumic concentration factor at 50°C. Three operating modes were investigated: constant transmembrane pressure, 90 and 53 psi, and constant flux. Fouling of the membrane system was characterized using the resistance-in-series approach. It was found that operating at constant flux increases ($P < 0.05$) the reversible fouling and consequently increases the energy requirement necessary to produce

milk concentrate in comparison with to operating at lower constant transmembrane pressure. Our results showed that transmembrane pressure control does not affect the irreversible fouling during milk protein concentrate production, 66.5 ± 0.6% protein. Also, the protein retention was not affected ($P < 0.05$) by changes in transmembrane pressure. This study demonstrates that milk protein concentration by UF at low transmembrane pressures limits the formation of cake layer (reversible fouling) and this improves the efficiency of the process by reducing the energy consumption during filtration and its environmental footprint.

Key Words: transmembrane pressure, fouling, energy

W149 Comparative performance of two membrane configurations for the separation of casein from bovine milk by microfiltration. Daniel Tremblay-Marchand[1], Alain Doyen[1], Michel Britten[2], and Yves Pouliot*[1], *[1]STELA Dairy Research Center, INAF, Université Laval, Québec, QC, Canada, [2]Agriculture & Agri-Food Canada, FDRC, St-Hyacinthe, QC, Canada.*

Microfiltration (MF) is increasingly used for the separation of casein micelles from serum or whey proteins (SP) in milk, using a 0.1–0.2 µm pore size membrane. One of the processing benefits of casein concentration by MF is that the co-product generated is considered as native or ideal whey. Ceramic graded permeability (GP) MF membranes ensuring long-term permeation flux and membrane selectivity have been successfully used for the separation of caseins from milk. Polymeric spiral wound (SW) MF membrane elements have also been reported to perform casein separation from milk but their performance has not yet been fully characterized. The objective of the present study was to compare the performance of 2 MF membranes configurations (SW vs GP) for the separation of casein from skim milk. The first membrane studied was a ceramic Membralox GP (model EP1940, Pall Corp.) with a 0.1-µm pore size and a surface area of 0.72 m^2 while the second was a polymeric polyvinylidene fluoride (PVDF) spiral-wound membrane (model V0.2–2B-3838, Synder filtration) with a 0.2 µm pore size and a surface area of 14.12 m^2 (2 elements). Both membranes were mounted on a Model 393 pilot-scale system (Tetra Pak, Champlin, MN). Experiments were performed at 50°C up to a concentration factor of 2×, 3×, and 4×. Permeation flux and changes in membrane resistance during MF were compared. Membrane selectivity (separation of caseins from whey proteins) was determined by chemical analysis (TN, NCN, NPN) and validated by SDS-PAGE electrophoresis. It was found that GP membrane had an average permeation flux 3 times higher than that of SW. The CN/TP ratio of the final retentates were similar for both membranes. The water flux of fouled membranes (before cleaning) was 40% and 60% of the initial water flux for SW and GP membrane respectively. Although casein separation could be achieved using the 2 membrane configurations (GP and SW), our observations suggest that the GP MF membrane offers better process control by maintaining a higher permeability and preventing severe membrane fouling upon casein separation from milk.

Key Words: microfiltration, casein, membrane

W150 Characterization of the early stages of biofouling during ultrafiltration of dairy fluids using polyethersulfone membranes in a model system. Julien Chamberland*, Marie-Hélène Lessard, Steve Labrie, and Yves Pouliot, *STELA Dairy Research Center, Institute of Nutrition and Functional Foods, Université Laval, Quebec, QC, Canada.*

Bacterial biofilms are known to affect operational performance of membrane filtration, but little knowledge is available concerning the mechanisms and factors involved in their formation. The present work aimed to characterize pioneer colonizer bacteria involved in biofilm formation on filtration membranes during dairy fluids treatments. In this context, a laboratory-scale crossflow filtration model system has been designed consisting in an assembly of 4 parallel filtration units (CF042, Sterlitech) each equipped with a UF membrane of 42 cm^2 flat polyethersulfone (PES) sheet with a molecular weight cut-off of 10 kDa. The dairy fluids studied were raw and pasteurized skim milk, unpasteurized cheese whey and pasteurized cheese whey from the same batch of raw milk. UF separations were performed in full-recycle mode at 40°C for 5 h. After UF operations, membranes were collected before and after cleaning procedure (pH 10.5, 150 ppm of free chlorine, 45°C, 30 min.) for DNA extraction (phenol-chloroform extraction). All experiments were performed in duplicate. A high correlation (R^2 = 0.93) was found between DNA recovery on UF membranes after water flush (before cleaning) and the initial microbial load of the fluid; whey pasteurization reduced significantly the amount of DNA recovered on the membrane coupons before cleaning ($P < 0.05$). After cleaning, genomic DNA was still detectable on membranes coupons. Indeed, preliminary results showed that even with a higher initial microbial load, unpasteurized cheese whey left the lowest amount of DNA (2.76 ng DNA/cm^2) compared with both milk samples (3.86 and 4.71 ng DNA/cm^2). Sequencing of the extracted metagenomic DNA is currently in preparation (MiSeq, Illumina) to establish the portrait of the rising bacterial ecosystem located on PES membranes. Our results will translate into designing processing conditions for a better control of biofouling and consequently process efficiency.

Key Words: dairy processing, biofouling, metagenomic

W151 In situ monitoring of lactose crystallization using focused beam reflectance measurement (FBRM). Karthik Pandalaneni* and Jayendra Kumar Amamcharla, *Kansas State University, Manhattan, Kansas.*

Lactose is the second most abundant component present in milk. It is commercially produced from whey or whey permeate or milk permeate by crystallization. The current problem is lack of efficient tool to monitor crystal sizes and chord lengths during industrial lactose crystallization (LC). The objective of this study was to use focused beam reflectance measurement (FBRM) as a tool for in situ monitoring of LC. A 2 × 3 factorial design was used, with temperature (20°C and 30°C) and concentration (w/w) (50%, 55% and 60%) as independent variables. Desired concentrations of lactose were obtained by dissolving commercial grade lactose in distilled water. The FBRM was placed in a batch crystallizer consisting of an overheard stirrer and a temperature-controlled waterbath. LC was monitored for 630 min using an in situ FBRM system to obtain chord length distributions (CLD) and crystal size distributions (CSD). CLD obtained from FBRM were recorded in the ranges of < 50 µm (fine crystals) and 50–300 µm (coarse crystals). At regular intervals, lactose concentration was measured using a refractometer to deduce extent of crystallization. The extent of crystallization increased rapidly during the first one hour of crystallization. The time required to reach 90% extent of crystallization at 30°C was found to be 300, 360, and 420 min for 60%, 55%, and 50% solutions, respectively. As the extent of crystallization increased, the fine crystal counts obtained from FBRM were also increased. It was observed that fine crystal counts increased with increasing supersaturated concentration (65,000 for 50% and 84,000 for 60% at 30°C) and temperature (59,000 at 20°C and 65,000 at 30°C for 60%). Square weighted CLD obtained from FBRM helped demonstrate that, as concentration increased there was a substantial decrease in chord lengths at 20°C. Mean chord lengths of lactose crys-

tals as observed by FBRM for 60, 55, and 50% at 20°C were 39.09, 40.52, and 57.64 μm, respectively at 630 min. In conclusion, FBRM in conjunction with refractometer could be used as a potential tool for in situ monitoring of LC process.

Key Words: lactose crystallization, focused beam reflectance measurement (FBRM)

W152 Influence of magnetic field exposure and clay mineral addition on the fractionation of Greek yogurt whey components. Clinton R. Kyle* and Jayendra K. Amamcharla, *Kansas State University, Manhattan, KS.*

Greek style yogurt in the United States is one of the largest growing sectors in the dairy industry. Greek yogurt is produced by removing a part of water and water-soluble components from yogurt. Consequently, a large quantity of Greek yogurt whey (GYW) is being produced as a co-product. The GYW is compositionally different from cheese whey, and thus posing economic and environmental challenges to the dairy industry. The objective of the present work was to evaluate the use of magnetic fluid treatment (MFT) and addition of sepiolite (IMV Nevada, NV), a clay mineral, as alternative methods for separating valuable GYW components. The MFT chamber was designed using 4 pairs of neodymium magnets arranged to produce a magnetic field strength of 0.6 Tesla. The GYW was pumped through the MFT chamber at a flow rate of 7.5 L/min. Three batches of GYW each from 2 manufacturers were procured. A 2 × 3 factorial design was used with MFT or no MFT and the addition of 0, 2, or 4 g of sepiolite for 100g of GYW. The pH of GYW was adjusted to 7.2 using 5 *N* NaOH, and processed in the MFT chamber. The sample was split into 3 sub-samples, heated to 80°C, and sepiolite was added as per the experimental design. Subsequently, the samples were centrifuged at 1000g for 5 min. The supernatant aqueous layer was separated and analyzed for total solids, ash, lactose, protein, calcium, phosphates, sodium, and color. Data were analyzed separately for each manufacture using the MIXED procedure in SAS software. MFT and its interaction did not significantly ($P > 0.05$) influence the analyzed whey components except for lactose. However, the addition of sepiolite significantly ($P < 0.001$) influenced the protein content, a*, and b* for the top aqueous layers. Both levels of sepiolite addition resulted in about a 50% decrease in protein compared with original GYW. Adding 2g of sepiolite per 100g of GYW form manufacturer 1 resulted b* decreasing from 25.99 to 8.16 compared with treated GYW with no sepiolite. Sepiolite was found to have possible applications in the removal of proteins and color pigments in Greek yogurt whey.

Key Words: Greek yogurt whey, magnetic treatment, sepiolite

W153 Characterization and oxidative stability of oleic acid-modified chitosan/milk protein nanoparticle containing docosahexaenoic acid. Ho-Kyung Ha*[1], Ji-Young Hong[1], Jae-Young Hwang[1], Won-Jae Lee[1], and Mee-Ryung Lee[2], *[1]Department of Animal Bioscience (Institute of Agriculture and Life Science), Gyeongsang National University, Jinju, Gyeongnam, Republic of Korea, [2]Department of Food and Nutrition, Daegu University, Gyeongsan, Gyeongbuk, Republic of Korea.*

The application of docosahexaenoic acid (DHA) to nonfat food is often challenging due to its poor bioavailability and susceptibility to oxidative rancidity. The aim of this study was to investigate how manufacturing variables, such as degree of substitution (DS) of oleic acid-modified chitosan and sub-ambient temperature treatment, affected the physicochemical properties of oleic acid-modified chitosan/milk protein nanoparticle (OPN) and reduction in oxidative rancidity. Oleic acid-modified chitosan with various DS ranging from 0 to 7.4% were prepared using a carbodiimide coupling method. OPN was manufactured at various sub-ambient temperature from 5 to 25°C. The morphology and size of OPN were investigated using atomic force microscopy and particle size analyzer, respectively. Encapsulation efficiency, oxidative rancidity, and off-flavor compounds of DHA were determined by high performance liquid chromatography, peroxide value, and gas chromatography/mass spectrometry, respectively. Globular shaped particles with the size of ~190 nm were observed indicating the successful formation of OPN. As DS increased from 0 to 7.4%, a significant ($P < 0.05$) increase in the size of OPN and encapsulation efficiency of DHA was observed. During storage, the peroxide value for OPN containing DHA was significantly ($P < 0.05$) decreased with an increase in DS. A decrease in sub-ambient temperature from 25 to 5°C resulted in a significant ($P < 0.05$) decrease in the size of OPN and increase in the encapsulation efficiency of DHA. The peroxide value for OPN containing DHA was significantly ($P < 0.05$) lower in comparison to free DHA although it was not significantly affected by sub-ambient temperature treatment. No significant ($P < 0.05$) off-flavor developments were observed in OPN containing DHA while free DHA exhibited a significant ($P < 0.05$) increase in off-flavor development during storage. In conclusions, DS and sub-ambient temperature treatment were crucial factors affecting the physicochemical properties of OPN and oxidative stability.

Key Words: milk protein, nanoparticle, docosahexaenoic acid

W154 Electrospinning casein-based fibrous mats for food applications. Peggy M. Tomasula*[1], Shih-Chuan Liou[2], Ran Li[3], Laetitia M. Bonnaillie[1], and LinShu Liu[1], *[1]USDA/Agricultural Research Service, Eastern Regional Research Service, Dairy and Functional Foods Research Unit, Wyndmoor, PA, [2]Chung Shan Medical University, Taichung City, Taiwan, [3]State Key Laboratory of Hollow Fiber Materials and Processes, School of Materials Science and Engineering, Tianjin Polytechnic University, Tianjin, China.*

Electrospinning is a process that produces fibrous mats from fibers with diameters on the micron or nano scales from an electrified jet of a polymer solution. If produced by electrospinning biopolymer solutions, the fibrous mats may have the same potential as edible films for protecting foods and improving food quality but also allow for preservation of sensitive nutrients. Electrospinning aqueous solutions of dextran, pullulan (PUL) and gelatin are known to result in homogeneous fibers. However, little information is available on electrospinning other food grade biopolymers. The objective of this study was to create fibers for food use from electrospinning aqueous solutions containing calcium (CaCAS) or sodium caseinate (NaCAS). A nanofiber electrospinning unit was used to generate the fibers at 40°C using voltage of 23 KV and flow rate of 0.5 mL/h. Fibers were not produced by electrospinning 5, 10, or 20% (w/w) solutions of either CAS, possibly because of little interaction among the CAS chains, but were produced when either of the 20% CAS solutions were blended with 15% or 30% (w/w) aqueous solutions of PUL in volume ratios from (2:1) to (1:4), using PUL as a spinnable carrier. The morphologies of the fibrous mats were determined using scanning electron microscopy equipped with software to sample 100 of the constituent fibers to calculate mean diameters. Electrospinning 15% PUL solutions resulted in fibers with diameters of 190 ± 50 nm. CaCAS:PUL solutions in volume ratios of (1:1) and (1:2) resulted in fibers with average diameters of 160 ± 40 nm and 1020 ± 600 nm, respectively. NaCAS:PUL solutions in volume ratios of (1:1) and (1:2) resulted in fibers with average diameters of 320 ± 30 nm and 340 ± 150 nm, respectively. The mean diameter of the CaCAS:PUL (1:1) fibers

was not significantly different from the pure PUL fibers, but the increase in size of the CaCAS:PUL (2:1) fibers and the NaCAS:PUL(1:1) and (1:2) fiber sizes may stem from changes in hydrogen bonding and thus the degree of entanglement of the PUL chains in the presence of CAS, compared with pure PUL solutions. This is the first example of CAS nano- and micro-fibers prepared using a polysaccharide carrier, rendering a new dairy product with potential use in food and packaging applications.

Key Words: fibers, nanoscale, polysaccharide

W155 Isolation of milk fat globule membrane (MFGM) from buttermilk. Liza Ivanov*[1], Vladimir Shritz[1,2], and Vitaly L. Spitsberg[1,3], *[1]Astrazemcal, Raanana, Israel, [2]Baemek Advanced Technology, Afula, Israel, [3]Biovita Technologies, Bat Yam, Israel.*

Due to a great interest in application of bovine MFGM as a nutraceutical (J. Dairy Sci. 88:2289–2294, 2005), we developed a new protocol for isolation of large amounts of MFGM from buttermilk. The protocol includes the following steps: precipitation of casein and MFGM at pH 4.6, treatment of the precipitated complex casein-MFGM with sodium phosphate at pH 4.6–8.0 or with polyphosphate (Calgon) at pH 7.1 and differential centrifugation (1000–2000 × *g* to get a pellet of casein and 32,000 × *g* (Strator centrifuge) to collect a pellet of MFGM. Maximum dissociation of MFGM from casein was achieved at pH 7.1–7.4. Yield of MFGM from 1 L of buttermilk treated with sodium phosphate at pH 7.2 was 789 mg of protein and treatment with Calgon at pH 7.1 also provided a high yield of MFGM, 725 mg/L. Treatment of precipitated casein with 0.1 *M* Na-citrate or Na-oxalate at pH 7.1 led to the isolation of MFGM in amount of 234 mg/L and 106 mg/L, correspondingly. Treatment of precipitated casein with 0.1 *M* NaCl or 0.1 *M* Na_2SO_4 did not produce a noticeable amount of MFGM. Recovery of MFGM from buttermilk allowed us to suggest that MFGM in buttermilk is present in association with casein through Ca- bridges between phospholipids of MFGM and phosphate groups of casein, primarily with k-casein as a peripheral protein of casein micelles. For production of large amount of MFGM on industrial scale the use of continuous-flow centrifuge and microfiltration were suggested. Baemek Advanced Technology supported this work.

Key Words: milk fat globule membrane (MFGM), nutraceutical, buttermilk

W156 Effects of surface modification on bacterial and spore adhesion in dairy handling materials. Garrett T. Walsh* and Rafael Jimenez-Flores, *California Polytechnic State University, San Luis Obispo, CA.*

The objective of this work was to demonstrate how stainless steel microstructure, material processing and surface treatment affect the attachment of spores, and the subsequent development of biofilms on the surface of AISI 316L Stainless steel, the typical milk handling and processing material. Stainless steel coupons with different surface finishes were prepared (as received, 220 grit, 400 grit and 800 grit) and characterized by contact profilometry and scanning electron microscopy. In addition, autogenously welded samples were produced for each surface roughness. Samples were exposed to both sterile and bioactive solutions for 5 and 20 h periods. Corrosion resistance was subsequently measured using cyclic polarization testing in each surface and solution pairing. Samples were examined using scanning electron microscopy and epifluorescence microscopy. The former was used to characterize surface damage, identify film presence, and examine spore attachments. The latter was used to quantify attachment of *Bacillus licheniformis* and to estimate the thickness of biofilms formed. The work has demonstrated that surface preparation had a significant effect on attachment and proliferation ($P < 0.05$). Furthermore welding had a significant effect on attachment and electrochemical reactivity ($P < 0.05$). The electrochemical reactivity of the material as measured by stable pitting potential and measured passive current is also affected by both surface roughness and by bioactivity of the solution. Metastable pitting is common in all solutions, stable pitting potential is lower in bioactive solutions and the passivation current is greater in bioactive solutions. Microstructure of the material is critical to its behavior, as is the complexity of the solution. Planktonic populations are not a direct indication of the sessile populations.

W157 The impact of milk hauling practices on overall raw milk quality. Emily Darchuk, Joy Waite-Cusic, and Lisbeth Goddik*, *Department of Food Science, Oregon State University, Corvallis, OR.*

Historically, milk tankers were cleaned after every load. Consolidation of the industry has led to longer routes and use of tankers for up to 24 h in between cleans. This study focused on the effect of frequent tanker use hauling on raw milk quality. Standard tanker use, (CIP once per 24 h) served as our control and incremental cleaning treatments (water rinse after each load, water rinse after each load with a 12 h sanitizer treatment, and 12 h sanitizer treatment) were added to the study to understand if any effect could be mitigated by more frequent cleans. Two trucks were isolated for this study, which utilized a mix model with repeated measures design. Each truck was utilized for up to 9 routes per day. To understand the effect of seasonality, the 8-d study was repeated in both summer and winter. Producer samples were collected from the farm bulk tank before loading raw milk into the tanker as well as sampling the same milk directly out of the tanker truck before unloading at the manufacturer. Milk quality was quantified through commonly utilized microbiological tests: total bacteria count, thermophilic spore count and preliminary incubation count. Within our study, we defined a negative effect on milk quality as a statistically significant ($P < 0.05$) difference between the producer and tanker sample in any of the 3 microbial tests conducted. Results did not identify a negative effect on raw milk quality due to hauling neither in summer nor in winter conditions. Therefore, the addition of cleaning treatments did not appear to provide a positive impact on milk quality. Based on this study, current practices appear to be effective in mitigating any measurable negative effect due to hauling.

Key Words: hauling, milk, quality