DAIRY FOODS: **TECHNICAL SESSION 2: ANALYTICAL / PROCESSING**

1007 (T065) Incidence of thermoduric bacteria and spores on selected Midwest dairy farms.

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Thermodurics can be present in milk even after pasteurization. The objectives of this study were to identify the origin and common species of heat-resistant bacteria occurring during summer and winter on Midwest dairy farms. Bulk tank milk samples were taken from 10 dairy farms along the South Dakota section of Interstate 29 with herd sizes ranging from 650 to 3500 lactating dairy cows. Milk samples were profiled for the prevalence of thermoduric bacteria (TDB) and spore counts (SC). In addition, corn silage samples and swabs of the milking clusters were taken at nine of the 10 dairies to profile the potential sources of TDB and SC. The samples were taken three times during winter (January to March) and summer (June to August), to track seasonal changes in the bacterial flora. During winter the average TDB counts in bulk tank milk were 2.61 log compared to 2.76 log TDB counts in summer. The SC was 1.03 log in winter, which is half the 2.06 log SC present in summer season ($P < 0.0001$). Corn silage sampled in winter contained 7.57 log TDB compared to an increased 10.77 log TDB during summer sampling. Concentrations of SC in corn silage reached an average of 6.3 log in winter compared to 11.81 log for summer ($P < 0.001$). The seasonal effect was evident with an increase in summer counts across the board for TDB and SC both, in the feed and bulk tank. *Bacillus licheniformis* was the predominant species identified in 62.4% of winter (85 total) and 49.4% of summer (83 total) samples. *Bacillus subtilis* made up 9.4% of the remaining winter isolates followed by *Bacillus sonorensis* at 8.2%, conversely, *B. sonorensis* made up 12% of summer isolates followed by *Bacillus pumilus* at 10.8%. *Bacillus licheniformis* is a ubiquitous microbe and was isolated from both TDB and sporeformer categories in all three sample types. There were larger increases in SC than TDB indicating summer conditions potentially increase the ability of sporeforming bacteria to proliferate over TDB. In conclusion, samples from bulk tank milk, milking cluster swabs, and corn silage at each of the 10 sites indicated *B. licheniformis* was the major contaminant regardless of season. In this experiment corn silage was determined as the major source of both TDB and SC over the milking clusters and relative to the levels in bulk tank milk showing significant higher concentrations in summer than winter.

Key Words: spores, thermoduric bacteria, corn silage, *Bacillus*

1008 [Withdrawn]

1009 (T067) Mechanisms and ways for improving heat stability of Micellar casein concentrates.

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Heat stability of proteins is the major hurdle in designing high protein containing heat stable foods and beverages with long shelf-life. Micellar casein concentrate (MCC) can be an ideal ingredient for such products. As MCC typically has > 90%w/w casein and is devoid of whey proteins, the mechanism of it's heat stability is expected to be different compared to milk powders and MPC. However, little is known about heat stability of MCC solutions, particularly at higher protein concentrates. The objective of the present study was to explore the mechanisms of heat stability of MCC and also investigate the effects of different additives on heat stability of MCC. Aliquot of MCC (12, 14, and 16% w/w protein) were prepared by diluting concentrated MCC retentate with glass distilled water. Experiments were designed with following treatments: 1) no treatment (control), 2) addition of sodium phosphate (SP) at 1, 5, 10, 25, 50 mML^{-1}, 3) addition of sodium citrate (SC) at 1, 5, 10, 25, and $50mML^{-1}$. The time required for visual precipitation or aggregation (generally referred as heat coagulation time (HCT) was measured using oil-bath at 140 and 120°C. The visual observations, calcium-ion activity and particle size were also measured. The HCT of control samples was 49 sec. The colloidal state of casein micelle, calcium activity and voluminosity of casein micelles seemed responsible for poor heat stability of MCC. Addition of SP. and SC at low level (1 mM) improved HCT by 15s compared to control samples., whereas their addition at 5, 10, and 25 mM exhibited significant improvement ($P < 0.05$) in heat stability at all protein concentration showing no aggregation when heated for more than 3 min at 140°C or 120°C. The color was also changed from opaque to translucent. However, increasing level of SP. and SC to 50 mM decreased both HCT and turbidity of samples. The addition of SP. and SC shifted the casein-mineral equilibria leading to decrease in free Ca-ion concentration as well as dissociation of colloidal calcium phosphate from casein micelle and increased negative charges of the casein micelle and hence increased repulsion, which contributed to increase in heat stability of MCC. The results of this study showed significant ($P < 0.05$) improvement in the heat stability of micellar casein concentrate using additives such as SP. and SC, which show promise to make shelf-stable MCC with higher protein content.

Key Words: micellar casein concentrate, heat stability, calcium chelators

1010 (T068) Influence of carboxymethylcellulose molecular weight on physicochemical properties and stability of whey protein-stabilized emulsions. S. Zhang*, and B. Vardhanabhuti, *University of Missouri, Columbia.*

Complexation of protein with polysaccharides at pH near the isoelectric point (*P*I) of protein has been widely used to improve the stability of oil-in-water emulsions. This is attributed to the fact that protein–polysaccharide complex formed a thick, dense and homogenous layer surrounding the droplets to prevent the flocculation. However, little is known about the effect of molecular properties of polysaccharides on emulsification properties of protein. The objective of this study is to assess the influence of carboxymethylcellulose (CMC) molecular weight on physicochemical properties and stability of whey protein-stabilized emulsions. Emulsions containing 5 wt% oil, 0.5 wt% protein and 0 to 0.5 wt% CMC (molecular weights of 270 k, 750 k, and 2500 kDa) were obtained by emulsification of oil with aqueous WPI–CMC solution at pH 7.0 through homogenization at 12,000 rpm for 1 min, followed by ultrasonic processing for 5 min. The emulsions were then slowly acidified to pH 5.2. Droplet size, zeta-potential, and rheological properties of emulsions were measured to characterize their physicochemical properties. Creaming index along with protein surface coverage were used to measure the stability of emulsions. In the absence of CMC, WPI emulsions were prone to flocculation. WPI–CMC emulsion showed improved stability, but was highly dependent on the molecular weight and concentrations of CMC. Addition of less than 0.1% CMC enhanced the adsorption of protein at the interface and increased the repulsion between droplets, resulting in more stable emulsions compared to WPI emulsions. Further addition of CMC did not change the surface coverage of protein, but increased the viscosity of the continuous aqueous phase, further contributing to the stability of emulsions. Emulsions with low molecular weight CMC showed much faster creaming rate than those with high molecular weight CMC during 15 d of storage. This is likely due to combined effects of higher protein surface coverage on the droplets and increased viscosity of the aqueous phase. The flow behavior of emulsions changed from shear-thinning to Newtonian and back to shearthinning, however, the concentrations where these changes occurred were dependent on the molecular weight of CMC. This study demonstrates that complexation of whey protein with high molecular weight CMC improves the surface properties of protein and enhances the repulsion between droplets, contributing to the stability of the emulsions. The outcomes could be applied to improve the stability of food emulsions having pH values near the pI of protein.

Key Words: CMC, molecular weight, emulsion

1011 (T069) Induction of pitting on stainless steel 304 and 316 by *Bacillus sporothermodurans*. S. Gupta[*1], and S. Anand[2], [1]*South Dakota State University, Brookings,* [2]*Midwest Dairy Foods Research Center, South Dakota State University, Brookings.*

Stainless steel (SS) undergoes corrosion in both polished and unpolished regions of dairy evaporators and dryers leading to product quality and economic concerns. The objective of this research was to investigate microbially induced corrosion (MIC) or pitting on SS 304 and 316 by a common milk contaminant; *Bacillus sporothermodurans*. These bacteria and their spores can persist on the SS milk contact surfaces in evaporators and dryers in the form of biofilms and may induce corrosion due microbial metabolic products such as enzymes, exopolymers, organic and inorganic acids and hydrogen sulfide. Many sulfate reducing bacteria (SRB) are active under oxygen stress and contribute to oxygen reduction reactions, thus influencing corrosion. In this study, polished and unpolished SS coupons (1'x1') of grades 304 and 306 were used to form biofilms of a dairy origin strain 10599 of *B. sporothermodurans* (Deutsche Sammlung von Mikroorganismen und Zellkulturen). This strain was found to exhibit sulfate reduction, as well as, proteolytic activities. About 10^7 cfu/mL of the overnight grown culture were inoculated in sterile 11% reconstituted non-fat dry milk (NFDM) in a Petri dish, in which sterile SS coupons were immersed. The incubation was performed at 30°C, being the optimum growth temperature of the culture. The suspension medium (NFDM) was replaced at regular intervals based on its pH drop to 5.0. bacterial counts from the spent media were taken at weekly intervals, while the biofilm counts were taken after every 2 wk to monitor the culture viability. The data were statistically analyzed to compare means. The counts in spent media and biofilms ranged from 10^5–10^6 cfu/mL and 10^2–10^4 cfu/cm^2, respectively. The coupons were examined using scanning electron microscope (SEM) for any corrosion or pit formation. Energy dispersive x-ray spectroscopy (EDS) was used to find the elemental composition of the control SS surface and was compared with that of the pits. From SEM observations and EDS data, it was established that pitting of surfaces for both grades of SS with biofilms got induced from wk 4 onward. These pits were distinct for the two grades; some pits were deep, while others were on the surface with corrosion products deposited over them. Elemental increase in sulphur and oxygen on the pit surfaces further confirmed the induction of corrosion. In conclusion, the biofilms of *Bacillus sporothermodurans* induced corrosion on the surface of stainless steel of both grades.

Key Words: corrosion, *Bacillus,* stainless steel, pitting

1012 (T070) Protective effect of lactic acid bacteria against H_2O_2–induced oxidative stress in Caco-2 cells. S. Liu[1], C. Man[2,3], X. Peng[1], W. Zhou[1], M. Guo[*4], and Y. Jiang[1,2,3], *[1]Dep. of Food Science, Northeast Agricultural University, Harbin, China, [2]Synergetic Innovation Center of Food Safety and Nutrition, Harbin, China, [3]National Dairy Engineering and Technology Research Center, Northeast Agricultural University, Harbin, China, [4]University of Vermont, Burlington.*

Oxidative stress can be defined as an imbalance between production of free oxygen radicals and reactive oxygen metabolism or repair the organism damage. A number of studies indicate that lactic acid bacteria (LAB) possess antioxidant activity due to their ability to regulate the activity of antioxidant enzymes during the cell metabolizing. The objective of this study was to establish a model of oxidative stress in human colon carcinoma cell line, Caco-2 cells, and to compare the protective effect of *Lactobacillus plantarum* NDC75017, *L. plantarum* ATCC14917 and *L. acidophilus* NCFM against hydrogen peroxide (H_2O_2)-induced oxidative stress in Caco-2 cells. The Caco-2 cells were divided into five groups: control group; oxidative stress group; *L. plantarum* NDC75017-protected group; *L. plantarum* ATCC14917-protected group and *L. acidophilus* NCFM-protected group. Caco-2 cells were exposed to 500 μM H_2O_2 in FBS-free DMEM for 30 min to induce oxidative stress, and then the three protection groups were respectively treated with 1×10^7 cfu/ml *L. plantarum* NDC75017, *L. plantarum* ATCC14917 and *L. acidophilus* NCFM suspended in FBS-free DMEM. After 4 h of incubation, the activity of intracellular antioxidant enzymes was measured. Superoxide dismutase (SOD) and catalase (CAT) activity were measured with the commercial kits based on colorimetric method, and the colorimetric reactions were determined at 450 nm and 405 nm, respectively. The data showed that CAT activity increased by 81% in oxidative stress group compared with control group, however no significant difference was observed in CAT activity between oxidative stress group and protection groups. SOD activity decreased by 33% in oxidative stress group compared with control group. All the three strains of the protection groups provided protection ($P < 0.05$) against H_2O_2–induced SOD activity reduction in different degrees, in which *L. plantarum* NDC75017-protected group showed the most significant increase in SOD activity by 44%. The results revealed that when the Caco-2 cell was suffering oxidative stress, the activity of intracellular antioxidant enzymes such as SOD and CAT would increase substantially. Some strains of LAB have positive effects on relieving oxidative stress and regulating intracellular antioxidant enzymes activity. Particularly *L. plantarum* NDC75017, which was isolated from traditional yogurt in Inner Mongolia of China, provided the greatest protection against H_2O_2–induced SOD activity reduction of the three strains, may have potential applications for use in the food industry. *This work was supported by National Science and Technology Project (2011AA100902).*

Key Words: oxidative stress, antioxidant enzyme, lactic acid bacteria

1013 (T071) fatty acid composition of cultured butter with probiotic *Lbc. acidophilus* La-5 produced in winter time. O. Tsisaryk[*1], L. Musiy[1], O. Golubets[2], and S. Shkaruba[2], *[1]Lviv National University of Veterinary Medicine and Biotechnologies, Ukraine, [2]Ukrmetrstandart, Kyiv, Ukraine.*

The objective of our study was to determine the fatty acid composition of sweet butter (SB) and cultured butter (CB) after *Lbc. acidophilus* was added to the starter. Control butter was churned from sweet cream (SB). Starters Flora Danica (*Lac. lactis, Lac. cremoris, Leu. cremoris, Lac. diacetilactis and Lbc. acidophilus La-5*), provided by Chr. Hansen, were used. Four groups of CB were produced: group 1, cream fermented at 30°C for 6 h by Flora Danica (CB1), 1:1 Flora Danica and La-5 (CB2) and La-5 (CB3); group 2, cream fermented at 37°C for 6 h by Flora Danica (CB4), 1:1 Flora Danica and La-5 (CB5) and La-5 (CB6); group 3 (Alnarps Winter method), left for 2 h at 8°Ñ, heated up to 20°Ñ and starter Flora Danica (CB7), 1:1 Flora Danica and La-5 (CB8) and La-5 (CB9) were added and fermented for 8 h, then cooled down to 12°Ñ and left for 10 h; group 4, starter Flora Danica (CB10), 1:1 Flora Danica and La-5 (CB11) and La-5 (CB12) were added to the butter grain. The experiment was replicated three times. Butter samples were stored at 20°C before the fatty acid analysis by GLC. The FAME were separated in a chromatography column (Hewlett-Packard 6890, 100 m × 0,25 mm × 0,2 μm [HP-88] 88%-cyanopropyl aryl-polysilixane, Agilent Technologies). The total content of the trans-9 isomers was 1.22 g in SB, whereas in CB2 the value was the lowest, i.e., 1.02 g/100 g of fatty acids. The total content of trans-11 isomers was the highest in CB2 (7.92 g/100 g) vs. 7.56 g/100 g of fatty acids in the SB ($P < 0.05$). Trans-11 C18:1 content increased from 5.19 in SB to 5.28–5.41% in the CB, the highest value observed for CB2 ($P < 0.05$). The percentage of cis-9,trans-11 CLA was the highest for CB2, CB5, CB6, CB8, when Flora Danica was combined with La-5, and for pure La-5 at 37°C (the optimal inoculation temperature for this strain). The total percentage of unpaired and branched-chain fatty acids was the same for all samples, but the percentage of medium-chain saturated fatty acids (C12-C16) slightly decreased from 37.34% in the SB to 37.0% in CB7 and CB9. CB1 and CB2 possessed the best taste, flavour and texture. Thus, adding La-5 into starter for cultured butter stimulates the 11-trans isomerisation of fatty acid and provides probiotic properties of cultured butter.

Key Words: butter, cultured butter, La-5, fatty acid

1014 (T072) Development of dairy products enriched with healthy lipids. J. Moats[*1,2], M. Epp[2], and D. Christensen[2], *[1]O&T Farms Ltd., Regina, SK, Canada, [2]University of Saskatchewan, Saskatoon, Canada.*

This study investigated the effects of feeding an extruded flaxseed product to dairy cattle on the fatty acid profile and sensory attributes of milk and Havarti cheese. The health benefits associate with certain lipids such as n-3 PUFA have been well documented. However, increasing the availability of these nutrients in dairy products for human consumption remains a challenge due to rumen biohydrogenation. Finding a mechanism for improving the fatty acid profile of dairy products without compromising sensory attributes would prove beneficial to the North American consumer. The hypothesis was: Feeding an extruded flaxseed product to dairy cattle would improve the fatty acid profile of milk and Havarti cheese without compromising sensory attributes. The objectives were: 1) to produce milk with elevated levels of n-3 through dietary means, 2) to produce Havarti cheese from control and n-3 milk, and 3) to evaluate the fatty acid profiles and sensory attributes of the milk and cheese. Six Holstein cows were offered a control diet followed by a treatment diet supplemented with an extruded flaxseed product with 70% flaxseed (LinPRO-R70) at 9% of TMR DM for 28 d. After the 28 d, milk samples were collected for compositional, fatty acid, and sensory analysis. Bulk milk samples were also collected and used to make Havarti cheese. Milk analysis showed a significant difference ($P < 0.01$) in total n-3 in the n-3 milk (1.25% FAME) compared to control milk (0.67% FAME). In a blind triangle test, sensory panelists were unable to identify source of milk indicating they were unable to detect any sensory differences between the control milk and the n-3 milk ($P < 0.01$). After 30 d of ripening, Havarti cheese was sampled for compositional, fatty acid, and sensory analysis. A significant difference in total n-3 ($P < 0.01$) was observed when comparing the n-3 cheese to control cheese. Cheese sensory results indicate that there were no differences in taste, texture or overall acceptability of the n-3 cheese compared to the control cheese. This trial suggests that including extruded flaxseed in the ration of dairy cattle may provide an opportunity for development and marketing of n-3 enriched dairy products.

Key Words: n-3, cheese, extruded flaxseed

1015 (T073) Evaluation of dulce de leche produced with different starches. F. Silva[1], H. Ferreira[2], M. Pinto[3], R. Stephani[2], A. Carvalho[*1], and Perrone[1], *[1]Federal University of Viçosa, Brazil, [2]Gemacom Tech, Juiz de Fora, Brazil, [3]Fedarl University of Viçosa, Brazil.*

Dulce de leche is technologically framed as preserved milk by evaporation and adding sugar. It usually presents creamy or pasty consistency, homogeneous texture, no lumps or flakes, bright caramel brown color, obtained by Maillard reactions and caramelization, peculiar aroma, and distinctive flavor, not too sweet or cloying. It presents good solubility in the mouth, and no perceptible sensory crystals. Starch is one of the main optional ingredients and can be used in its native form or modified. It can contribute to improve consistency and yield due to water retention, or assist in lactose crystallization control, by reducing the perceived appearing of crystals. The aim of this study was to evaluate the composition and properties of dulce de leche obtained with different types of modified starches, added in different concentrations of soluble solids during manufacturing. In this work, formulations of dulce de leche were prepared with different values of soluble solids concentration (39, 48, and 56°Brix). Yield, color, physicochemical composition, texture, crystal formation and sensory evaluation of dulce de leche were evaluated. Starch configures an important optional ingredient to production of dulce de leche, since increase shelf life without changes in texture, composition and yield characteristics of the product. Analysis revealed that the addition of starch reduced the formation of lactose crystals sensorially perceptible in almost all replications over the storage period. Further, dulce de leche with starch presented a good sensory acceptability among the analyzed attributes (color, texture, flavor and overall impression) and only significant difference ($P < 0.01$) was found for color. This was expected as the processes of the Maillard reaction and caramelization are associated with the dimming of the sweet, these reactions are less intense in this treatment.

Key Words: dulce de leche, starch, technology

1016 (T074) Rheological behaviors of edible casein-based packaging films under extreme environmental conditions, using humidity-controlled dynamic mechanical analysis. S. Akkurt[1], L. M. Bonnaillie[2], H. Zhang[1], and P. M. Tomasula[*2], *[1]Rutgers University, Dep. of Food Science, New Brunswick, NJ, [2]Dairy & Functional Foods Research Unit, Eastern Regional Research Center, Agricultural Research Service, USDA, Wyndmoor, PA.*

Thin casein films for food packaging applications possess good strength and low oxygen permeability but low water-resistance and elasticity. Customizing the mechanical properties of the films to target specific behaviors depending on temperature and humidity changes would enable a variety of commercial applications for casein-based films. The mechanical properties of edible films are vitally important to determine possible uses, such as replacement for plastic films. Dynamic mechanical analyses under controlled humidity (DMA-RH) can supply useful information about the mechanical properties and network-structure of hydrophilic protein films, including the storage modulus (E'), loss modulus (E"), deformation (swelling and shrinkage), damping behavior (tan-δ), as well as various transition temperatures and humidities. The dynamic

mechanical properties of solvent-cast (15% solids) calcium-caseinate/glycerol films (CaCas:Gly ratio 3:1) were fully characterized on a broad range of temperature (T = 5–90°C) and humidity (RH = 0–80%) using DMA-RH technology to study behaviors under normal or extreme environmental conditions. Citric pectin (CP, 0.05 to 1 wt.%) was then incorporated into CaCas films as a crosslinker using three different formulations (A, F, G) to examine CP effects on the properties and macrostructure of CaCas/Gly/CP films, and improve the stability of CaCas film under high humidity or temperature. The mechanical properties of casein films were extremely sensitive to formulation, CP content, T and RH, and DMA-RH technology proved a precise and effective tool to characterize composition/properties trends and point out various transition temperatures during T-ramps at 50% RH, and "transition humidities" during RH-ramps at 20°C. Transition-T and RH were considered to correspond to different critical points at which sufficient plasticization with water and/or heat triggered various rearrangements of the CP/protein/water network, until ultimate film-failure at the "melting point." DMA-RH enabled to precisely characterize shifts in E', E'' and tan-δ, as well as shifts in the various transition-T and transition-RH caused by different formulations or increased CP contents. Generally, the addition of CP improved the environmental stability of CaCas films: after addition of 1% CP, the melting-T increased from ~40°C to ~60°C, and the "melting-RH" from ~58% to ~67%, depending on formulation. F films showed the most drastic improvement with increased CP content, while G films appeared stronger and generally more T- and RH-stable at all CP contents. Improving the strength and environmental stability of casein-based films will broaden their possible range of application, such as use in edible food packaging.

Key Words: calcium caseinate, thin films, DMA

1017 (T075) Evaluation of a laboratory-scale batch crystallizer for lactose isolation from deproteinized whey. S. Beckman*, S. Anand, and L. Metzger, *Midwest Dairy Foods Research Center, South Dakota State University, Brookings.*

Accurate replication of industrial-scale lactose crystallizations on a laboratory-scale apparatus has been a challenge for researchers wanting to improve lactose yield from dairy streams. The objective of this experiment was to develop a repeatable method for lab-scale batch crystallization of lactose from concentrated deproteinized whey (DPW). Commercial DPW powder was reconstituted to 60% total solids (wt/wt) in 80°C distilled water and held with agitation for 15 min for complete solubilization of lactose. The 80°C reconstituted DPW solution was immersed in an ice water bath to rapidly (15 min) cool to 50°C. Once the temperature reached 50°C, seed crystals were added (0.027 g per 100 g solution) to the DPW solution, mixed thoroughly, and held at 50°C with agitation for 1 h. After 1 h at 50°C, the solution was split into two portions by weight, and poured into lab-scale crystallizers. The crystallization apparatus consisted of a glass beaker with a PTFE magnetic stirrer and vanes for agitation. Stirring rate was maintained at 100 rpm throughout the cooling profile. The immersed crystallizer temperature was maintained by immersing a coil attached to a recirculation water bath into the bath surrounding the crystallizer. Crystallizers were cooled from 50 to 20°C at a rate of -0.130 ± 0.007°C per min. At the end of crystallization, the crystallizer was decanted and crystals were harvested from the bottom of the beaker for analysis. Recovered lactose crystals were observed microscopically (40×) to determine mean crystal size. Micrographs of lactose crystals were analyzed using image analysis software provided by the manufacturer of the microscope. A minimum of 10 crystals from each micrograph were measured for height, recorded as the length (μm) of the longest side, and duplicate micrographs were analyzed to improve accuracy. Three crystallizations were performed using the same lot of DPW reconstituted to 60% total solids. Results indicated that mean lactose crystal length obtained using this method were 21.36 ± 7.42 μm, with some larger (> 90 μm) crystals present in low numbers. Many small (< 10 μm) crystals were observed (not enumerated), which indicates the presence of secondary nucleation during cooling. The crystal sizes obtained using this method were small compared to what is encountered in industry. Small crystals would be easily lost during subsequent refining steps, decreasing yield. An optimized cooling profile, agitation speed during cooling, and crystal isolation scheme should be considered for future developments of this method.

Key Words: lactose, crystallization, lab-scale

1018 (T076) Dispersibility, suspension ability, solubility, and gelation properties of rehydrated frozen highly concentrated micellar casein. Y. Lu[1], D. J. McMahon[*1], and L. Metzger[2], [1]*Western Dairy Center, Utah State University, Logan,* [2]*Midwest Dairy Foods Research Center, South Dakota State University, Brookings.*

Highly concentrated micellar casein (HCMC), a potential ingredient of protein fortified food, is a gel at cold temperature containing ~20% casein with whey proteins and lactose removed by microfiltration (and diafiltration) of skim milk. Dispersibility, suspension ability, solubility, and gelation properties of rehydrated frozen HCMC were characterized. Thawed HCMC was reconstituted to 3% protein with water or trisodium citrate buffer and adjusted to pH 7 then mixed using 1 min of high shear (7500 rpm) at 4, 12, 20, and 50°C, or 30 min of low shear (800 rpm) at 4, 20, and 50°C, followed by 18 h storage at 4°C. Dispersibility was defined as percentage by dry weight of HCMC that did not pass through a 250-μm sieve. Material that was 100% dispersible was centrifuged for 5 min and tested for suspension ability (using 80 *g*) and solubility (using 20,000 *g*). Protein in the supernatant was measured and

suspension ability and solubility calculated as percent protein that was not sedimented during centrifugation. The HCMC was also rehydrated with cream to obtain casein-to-fat ratio of 0.8 with casein levels from 9.3% to 12.5%, adjusted to pH 7.0, then stirred at 800 rpm for 30 min at 50°C, Gel modulus (G', G'') was measured at 50°C followed by cooling at 1°C/min to 5°C. At temperatures $\leq$ 20°C, HCMC was only partially dispersible in water (e.g., 60% dispersibility using high shear at 4°C), while at 50°C it was 100% dispersible. Mixing at $\leq$ 20°C followed by overnight hydration at 4°C also produced 100% dispersibility. Suspension ability at 50°C was ~90%, while mixing HCMC at $\leq$ 20°C followed by overnight hydration yielded only 50 to 60% suspension ability. Solubility followed a similar trend with HCMC having ~85% solubility at 50°C and only ~30% solubility at $\leq$ 20°C. Mixing HCMC in 60 mM trisodium citrate increased dispersibility, suspension ability and solubility of HCMC at 4°C to 97, 75, and 75%, respectively. Gelation temperature of the HCMC-cream mixture, defined as temperature at which G' = G'' was positively correlated (R^2 = 0.71) with casein level. Gelation occurred at ~35, ~25 and ~15°C with 12.5, 10.5, and 9.5% casein, respectively. This process was reversible with a hysteresis effect observed depending on whether the mixture was being heated or cooled. With a 10.5% casein HCMC-cream mixture exhibiting G' at 15°C of 30 Pa during cooling and 160 Pa during warming.

Key Words: casein, microfiltration, gelation