SYMPOSIA AND ORAL SESSIONS

Dairy Foods: Dairy Products and Processing II

509 ADSA Pioneer: Collegiate dairy products evaluation-past and future. R. T. Marshall*, *University of Missouri*, *Columbia*.

Collegiate Dairy products evaluation was initiated to help train students on the attributes of dairy products and to set standards for good products. Soon team were formed and competitions were initiated. Both regional and national events were organized to increase team participation and training. Over the years milk quality and product quality has improved, thus some defect that were common in the early days of evaluation are no longer a problem. However, as modern technology improved manufacturing other problems became apparent. Thus, collegiate evaluations are as important today as they were 5 decades ago.

510 Performance comparison of ceramic and polymeric microfiltration (MF) membranes for separation of casein and serum protein (SP) from skim milk at 50°C. J. Zulewska*[1], M. W. Newbold[2], and D. M. Barbano[2], [1]*University of Warmia and Mazury*, *Olsztyn, Poland*, [2]*Cornell University*, *Ithaca, NY*.

Skim milk was pasteurized (72°C for 16 s), cooled and split into 3 batches for processing with different MF membranes: 0.1 micron ceramic uniform transmembrane pressure (UTP) 763 kg of milk in 342 min with 1.7 m^2 of membrane, 0.1 micron ceramic gradient porosity (GP) 780 kg of milk in 264 min with 1.7 m^2 of membrane, and 0.3 micron polymeric (polyvinylidene fluoride) spiral wound (SW) 1167 kg of milk in 130 min with 20.5 m^2 of membrane. For all membranes, a bleed and feed filtration was applied for continuous production of 3X MF retentate at 50°C and replicated 3 times. Flux was recorded every 10 or 15 min during the process run and mean flux (± SD) for UTP, GP, and SW were significantly different: 54.1±1.52, 71.8±1.68 and 16.2±4.75 ($kg/m^2/h$), respectively. The mean SP content in the MF permeate portion of the skim milk was 0.62%. The true protein content (Kjeldahl total nitrogen minus nonprotein nitrogen multiplied by 6.38) of the MF permeates from UTP, GP and SW were 0.57, 0.56, and 0.38% respectively, with both UTP and GP significantly higher than SW. Therefore, the coefficients of rejection for milk SP by the 3 membranes were 0.074, 0.090, and 0.383 and mean SP removal was 64.4, 61.0 and 38.6% of the original total weight of SP in the milk for UTP, GP and SW, respectively, with all means being significantly different. The UTP membranes produced a 64 to 65% SP reduced 3X MF retentate in one stage. The SW membranes would require a second stage with diafiltration using UF permeate to produce an MF retentate with about 65% SP reduction and the same background concentration of lactose and soluble minerals. The relative proportions of different SP may differ among the MF permeates and retentates with different systems. The MF permeate opacity increased with increasing L value: UTP 19.4, GP 19.9, and SW 20.5, with all permeates being significantly different from each other. MF permeate clarity may be important when the SP concentrates are used for clear nondairy beverage fortification.

Key Words: Microfiltration, Serum Proteins, Separation

511 Functional properties of whey proteins affected by heat and high pressure shearing. M. Dissanayake and T. Vasiljevic*, *Victoria University*, *Melbourne, VIC, Australia*.

Whey proteins (WP) are a functionally excellent food ingredient extensively used in various food applications. The major challenge affecting their functionality and applicability is the heat-induced destabilization during WP concentration, processing and preservation of food products containing WP.

The main objective of this study was to examine the effects of complete protein denaturation and extent of dynamic high-pressure shearing on colloidal and surface properties of microparticulated WP to produce novel ingredients with improved heat stability and modulated functionalities.

The study was carried out using randomised full factorial design with heat and high pressure as the major factors. Two different batches of WP retentates (10% protein content, pH 7) were subjected to complete heat denaturation and pressure sheared using different number of passes

at 140Mpa. Microparticulated WP were then spray dried. All powders were assessed for their solubility, heat stability and coagulation time, emulsifying and foaming properties. Effects of denaturation and shearing were also examined using SDS-PAGE and size exclusion HPLC.
Heat treatment significantly decreased the solubility of treated samples while the number of passes markedly improved it. The combined effect of heat and pressure significantly improved the heat stability as depicted by the heat coagulation time. The emulsifying activity index also significantly increased upon heat denaturation, which was even further enhanced by pressure. The emulsion stability appeared unaffected by the combined treatment, but the concentration of adsorbed protein on the surface of fat droplets increased significantly. Foaming properties (overrun and foam stability) were detrimentally affected by heating. SDS-PAGE and SE-HPLC revealed disappearance of major WP and creation of high molecular weight aggregates and smaller molecular weight species as a result of heat and shearing.
The study showed that this approach could be used to stabilize WP against heat by producing various microparticulated species, which also have different surface and colloidal properties from native WP.

Key Words: Whey Proteins, Microparticulation, Functionality

512 Production of whey protein concentrate 80 with improved clarity and flavor. I. Jarto*[1], J. A. Lucey[1], S. Damodaran[1], S. A. Rankin[1], and K. E. Smith[2], [1]*University of Wisconsin*, *Madison*, [2]*Wisconsin Center for Dairy Research*, *Madison, WI*.

The objective of our study was to develop a pilot-scale whey pretreatment process that reduced the residual lipids in whey protein concentrate 80 (WPC80) to < 1% by employing chitosan to selectively precipitate lipids (US Patent# 5,436,014). Our hypothesis was that a reduction in the concentration of residual lipids in WPC80 would improve WPC clarity and flavor by removing small fat globules and phospholipids which are prone to oxidation. The process used a low concentration of chitosan (0.01% wt/wt), which formed a complex with membrane lipids at pH 4.5. The chitosan-lipid complex was allowed to settle and a 0.3 μm polymeric microfiltration (MF) membrane was utilized to process the supernatant from this reaction. There were 2 treatments and a control: WPC80 treated with chitosan and followed by MF (WPCC); WPC80 treated with MF only (WPCB); and WPC80 without chitosan or MF (WPCA). Treatments were done in duplicate. No significant differences were observed in flux during processing runs up to 4 hours with final retentate concentration factor of 12X. Fat content of the WPCC, WPCB, and WPCA was 0.46±0.07%, 0.46±0.02%, and 6.56±1.31%, respectively. The turbidity was measured by absorbance at 500 nm (5% protein solution). The absorbance values for the WPCC, WPCB, and WPCA were 0.05±0.01, 0.08±0.01, and 2.61±0.20, respectively. Commercial samples of WPC80 (WPCG) and whey protein isolate had absorbance values of 2.91±0.10 and 0.08±0.02, respectively. Samples were subjected to an accelerated storage (4 d at 60°C). WPCG and the WPCA browned considerably and developed intense off-flavors. WPCC remained white and WPCB underwent slight browning; both exhibited low levels of off-flavor development. Gas Chromatography-Mass Spectometry was used to evaluate volatiles in WPC samples. Our study showed that chitosan pretreatment in the production of WPC80 resulted in greatly improved clarity and suppressed off-flavor and color development during accelerated storage, which suggested that this ingredient could be used to fortify clear beverages or be used in baking applications where browning was not desired.

Key Words: Whey Protein Concentrate, Chitosan, Clarity

513 Production of structured lipids containing palmitic acid for infant milk formulation and characterization of their oxidative stability. C. O. Maduko[1], C. C. Akoh[1], R. R. Eitenmiller[1], and Y. W. Park*[2,1], [1]*University of Georgia*, *Athens*, [2]*Fort Valley State University*, *Fort Valley, GA*.

Developing infant milk fat similar to human milk fat (HMF) is of great interest and challenge to food processors. The sn-1,3 positions of the triacylglycerols of most vegetable oils are occupied mainly by saturated fatty acids, while these positions of human milk contain mainly unsaturated fatty acids. Structured lipids containing similar fatty acid structure as HMF can be produced by interesterification reactions using an sn-1,3-specific lipase that gives high selectivity and mimics the natural pathways of metabolic processes. This study was to produce structured lipids (SLs) for infant milk formulation by enzymatic interesterification of tripalmitin with vegetable oil blends and fish oil, and characterize oxidative stability of the starting oils, and their SLs with and without tocopherol. SLs were synthesized in a bioreactor by enzymatic interesterification of a 1:3 molar ratio of tripalmitin to oil blends. The SLs were analyzed for fatty acid content and structure, melting profiles, oil stability index (OSI), free fatty acid (FFA) and tocopherol content. The OSIs of different lipid preparations were determined at 110 oC with an Oil Stability Instrument by AOCS method. Oxidative stability was determined by quantifying FFA, peroxides (peroxide value) and aldehydes (p-anisidine value) production. Total oxidation (TOTOX value) was calculated as 2 x (peroxide value) + (p-anisidine value). The structured lipids after purification by distillation had melting profiles, oil stability index, and initial FFA concentration that were similar to that of the starting oils, while the fatty acid composition and structure of the SLs were similar to that of human milk fat. Oxidative stability of the SLs was improved with tocopherol addition as antioxidants and was comparable to that of the vegetable oils and oil blends.

Key Words: Infant Milk Formulation, Structured Lipids, Oxidative Stability

514 The impact of fat globules' colloidal stability on the pre-gelation stages of rennet coagulation process. Z. Gaygadzhiev*, M. Alexander, A. Hill, and M. Corredig, *University of Guelph*, *Guelph, ON, Canada*.

The effect of the state of flocculation of fat globules on the early stages of rennet-induced gelation of model recombined milk was investigated. Fat globules differing in their degree of flocculation and with well defined sizes were prepared by emulsifying anhydrous milk fat in solution of whey protein isolate. Pre-gelation behaviour of recombined milks was studied in situ using diffusing wave spectroscopy (DWS). In addition, confocal microscopy and small deformation rheology were employed to observe the gel microstructure and viscoelastic properties, respectively. DWS experiments revealed dissimilarity in the structural organization of rennet-induced gels containing non-flocculated and mildly flocculated WPI-stabilized fat globules, as observed by the development of the turbidity parameter, 1/l*. The evolution of storage moduli, G', of recombined milk during the gelation process confirmed the results from the light-scattering experiments. Results demonstrate the importance of the aggregation state of the oil droplets in the formation of rennet-induced gels: mildly flocculated fat globules contributed to the formation of much stiffer gels compared to non-flocculated fat globules.

Key Words: Fat Globules' Flocculation, Rheology, Rennet Coagulation

515 Impact of changing temperature after measurable gelation on the properties of fermented milk gels. Y. Peng*[1], D. S Horne[2], and J. A Lucey[1], [1]*University of Wisconsin*, *Madison*, [2]*Formerly of Hannah Research Institute*, *Ayr, Scotland*.

Incubation temperature (IT) is an important parameter that affects many properties of yogurt gels including growth rate of culture, aggregation of caseins and strength of protein interactions. We wanted to understand how IT impacted gel properties by altering IT after we could instrumentally detect gel formation had occurred. This approach would help us to understand how IT influences events up to the initial measurable point of gel development as well as during the subsequent development of the gel network. Gels were made at different IT (30, 33.5, 37, 40.5 and 44°C) until gelation, then they were heated or cooled to 37°C at 1°C/min and maintained at 37°C until pH 4.6. Gelation was defined as the point when gels had a storage modulus (G′) of ≥5 Pa. Control gels were made at these IT (i.e., no IT change during gelation or gel development). A single strain of *Streptococcus thermophilus* was used to avoid variations in the ratios of strains that could have resulted from changes in IT. Dynamic low amplitude oscillatory rheology was performed to monitor the formation of gels. Microstructure at pH 4.6 was studied using fluorescence microscopy. Whey separation was analyzed at pH 4.6. The gelation pH decreased and gelation time increased with a decrease in the IT used up to measurable gelation. There were no significant differences ($P<0.05$) in G′ values at pH 4.6, maximum loss tangent, microstructure and whey separation in gels that were made with different IT up to measurable gelation but had the same IT after that point. There were significant differences in properties of gels where different ITs were used without any IT changes during fermentation. Altering IT after measurable gel formation resulted in a change in the rate of development of G′ and loss tangent of gels, indicating that IT altered the rate of rearrangements/fusion of caseins in the network. The results of this study suggested that changing IT during yogurt fermentation might be another approach to modifying the physical properties of yogurt. High IT could be used to reduce the gelation time and lower IT could be used to produce gels with improved textural properties.

Key Words: Gel, Temperature, Gelation

516 Rheological properties of stirred yoghurts made with whey protein isolate-pectin complexes as stabilizing agent. M.-C. Gentés*[1,2], S. L. Turgeon[1], and D. St-Gelais[2], [1]*STELA Dairy Research Centre and Institute of Nutraceuticals and Functional Foods (INAF)*, *Quebec,QC, Canada*, [2]*Food Research and Development Centre, Agriculture and Agri-Food Canada*, *Saint-Hyacinthe, QC, Canada*.

Problems of syneresis and viscosity in stirred yoghurts remain despite of the use of stabilizers. Whey protein isolate-pectin complexes can be used as stabilizers. Complex formation could confer different functional properties than individual compounds. Complexes were formed under associative conditions via electrostatic interactions at pH 4.5. As complexes were added at standardization step, they must be stable at pH 6.7. Prior study showed that a heat treatment at 90°C for 2 minutes was sufficient to stabilize them. Syneresis, apparent viscosity, hardness and microstructure were determined in stirred yoghurts produced with unheated complexes (UC), heated complexes (HC), pectin used in complex formation (PC) and commercial pectin (CP) at 3 concentrations (0.05, 0.1 and 0.2%). Analysis of variance, according to a factorial design, was applied to determine the effect of stabilizers on rheological properties. Significant differences were tested at $P\leq0.05$. Measurements were made after 4 days of storage at 4°C. Syneresis was significantly lower in CP yoghurts than in other yoghurts. The use of UC at 0.1% gave significantly the greater values of hardness and apparent viscosity comparatively to the use of HC. Microstructure of HC yoghurts showed larger aggregates than UC yoghurts. Double heat treatments (stabilization of complexes and pasteurization step) undergone by HC was not beneficial probably because an extensive whey protein aggregation leading to disruption of the casein network. This work showed that UC can be used to improve rheological properties of stirred yoghurt. The stability of complexes in UC after addition into milk should be evaluated.

Key Words: Yogurts, Complexes, Rheological Properties

517 Changes in relative percentages of fatty acids in raw goat milk, its yoghurt and salted yoghurt during manufacture. Z. Guler*[1] and Y. W. Park[2], [1]*Mustafa Kemal University*, *Antakya, Hatay, Turkey*, [2]*Fort Valley State University*, *Fort Valley, GA*.

In Mediterranean and Southern regions of Turkey, ‘Salted yoghurt’ or ‘Winter yoghurt’ is produced by boiling and salting yoghurt to prolong its storage life. The cooking and salting processes ensure microbiological safety and keeping its quality for smoother and whiter products. The objective of the study was to quantify the changes in fatty acids compositions of raw milk, yoghurt and salted yoghurt from Turkish indigenous milking goats. Fatty acid profiles were assayed using a GC-MS (Agilent model 6890; Palo Alto, CA, USA) with 5973 N (Agilent) mass selective detector. Mean relative percentages (%) for fatty acids of raw milk, yoghurt and salted yoghurt were: acetic acid (C2:0), 4.88, 2.03 and 1.17; butanoic acid (C4:0), 1.30, 0.27 and 1.69; hexanoic (C6:0), 4.28, 2.48 and 4.65; octanoic (C8:0), 1.23, 0.76 and 1.80; decanoic acid (C10:0), 4.91, 3.06 and 6.46; dodecanoic acid (C12:0), 2.26, 1.70 and 2.55; tetradecanoic acid, (C14:0), 8.48, 7.88 and 9.76; pentadecanoic (C15:0), 0.75, 0.21 and 0.18; hexadecanoic acid (C16:0), 37.5, 39.1 and 39.7; heptadecanoic acid (C17:0), 0.88, 0.99 and 0.93; octadecanoic acid (C18:0), 19.9, 23.2 and 17.8; 9-octadecanoic acid (C18:1), 13.6, 16.6 and 12.80, respectively. The highest amount of fatty acids in descending order of the three milk products were palmitic (C16:0), stearic (C18:0), oleic (C18:1), myristic (C14:0), and capric acid (C10:0). Decreases in C2:0 to C15:0 fatty acids were observed during yoghurt-making process, with the most marked reduction in C2:0 to C12:0 acids. This could be attributed to evaporation of these fatty acids during heating process of yogurt. The relative percentages of C4:0 to C14:0 acids increased during salted yoghurt processing procedures, probably due to the fat content increase in total solids. However, percentages of C2:0, C15:0, C18:0 and C18:1 decreased, while C16:0 and C17:0 acids were unchanged during the manufacture.

Key Words: Turkish Goat Milk, Salted Goat Yogurt, Fatty Acids Profile