of these two models. The heritability estimates in the IPM model were 0.17, 0.30, 0.15, 0.16, 0.33, 0.20, 0.51, 0.38, 0.38, 0.42 and 0.42 for traits DP, CLMB, ABT, P2, LEA, HY, LP, FP, LCP, FLR, and LTGR, respectively. The FPM model yielded clearly lower estimates for traits CLMB, ABT, P2, HY, LP, FP, LCP and FLR, respectively. The FPM model revealed posterior evidence for at least one MG at decisive level for traits CD, LEA, LCP and LTGR; at strong level for traits CLMB, FP and FLC; and at positive level for traits P2 and HY. The combined model yielded decisive evidence for presence of one MG for traits CD, LEA and LTGR, while the heritability estimates for these traits were 0.11; 0.36 e 0.17, respectively. These findings suggest that the genetics of growth and carcass traits may be better studied by using models that combine polygenic and major gene effects.

Key Words: swine, finite polygenic model, major genes

W61 Factors affecting weaning-to-first service interval in a Landrace-Large White swine population in Northern Thailand. C. Chansomboon[1], S. Koonawootrittriron[1], M. A. Elzo*[2], and T. Suwanasopee[1], [1]*Kasetsart University, Bangkok, Thailand*, [2]*University of Florida, Gainesville.*

Non-productive sow days measured as weaning-to-first service interval (WSI) is an economically important trait in commercial swine production. Thus, a reduction in WSI would help increase efficiency and lower production costs. The aim of this study was to characterize factors affecting WSI in a Landrace-Large White commercial swine population in the province of Chiang Mai, Northern Thailand. The dataset contained 12,974 litter records from 2,596 sows collected from 1989 to 2008. Sows were raised in an open-house system and received the same feeding and management. Sows were from 4 breed groups: Landrace (L), Large White (Y), L × Y (LY), and Y × L (YL). Parity of sow was classified as 1, 2, 3, 4, 5, 6, and ≥ 7. Seasons were winter (November to February), summer (March to June), and rainy (July to October). Preliminary analyses showed no effect of age at farrowing of the sow and number piglets weaned on WSI. Thus, the model for WSI contained the fixed effects of farrowing year-season of the sow, parity of the sow, lactation length, and breed group of sow, and a random residual effect. Year-season of farrowing was an important source of variation ($P < 0.01$). Year-season effects for WSI ranged from 4.60 ± 0.51 days (1991-summer) to 9.22 ± 0.87 days (1989-rainy). The WSI was longer ($P < 0.01$) for first-parity sows (7.91 ± 0.12 days) than for sows of other parities (5.72 ± 0.15 days to 6.10 ± 0.12 days). Landrace sows had similar WSI (5.89 ± 0.09 days) to Y sows (6.00 ± 0.09 days). Crossbreds LY sows (6.23 ± 0.16 days) and YL sows (6.67 ± 0.16 days) had longer WSI than purebreds sows ($P < 0.01$). Heterosis estimates were 0.29 days (4.8%) for LY sows, and 0.73 days (12.2%) for YL sows. Reciprocal differences for WSI indicated that LY sows had lower production costs than YL sows. Crossbred sows had longer WSI than purebred sows, perhaps due to lower adaptability to tropical conditions and unmet higher nutritional requirements.

Key Words: swine, weaning-to-first-service interval, tropical

W62 Use of random regression models for the genetic analysis of weight gain from electronic swine feeders. C. Y. Chen*[1], I. Misztal[1], S. Tsuruta[1], B. Zumbach[1,2], M. Łukaszewicz[1,3], W. O. Herring[4], J. Holl[4], and M. Culbertson[4], [1]*University of Georgia, Athens*, [2]*Norsvin, Hamar, Norway*, [3]*Institute of Genetics and Animal Breeding, Polish Academy of Sciences, Wólka Kosowska, Poland*, [4]*Smithfield Premium Genetics Group, Rose Hill, NC.*

Body weights (BW) of 1,921 Durocs from electronic feeders were used for genetic analysis of weight with random regression models (RRM). Daily, weekly, and bi-weekly average daily gain (DG, DGW, and DGB) were calculated from the average daily BWs with 69,068 records of DG. Estimates from various RRM for DG were erratic. Subsequent tests using a repeatability model for DG, DGW and DGB indicated that heritability of daily gain averaged over d days is approximately 1/(3.3+100/d) and is very low for DG (< 1%) but higher for DGW (6%) and DGB (9%). Subsequent analyses with RRM used DGB. Two RRM were used: with quadratic Legendre polynomials (RRM-L) and with three knot (100, 125, and 150 d) linear splines (RRM-S). Effects in the model included fixed year-biweek-pen and random litter, animal, permanent environment. For both models, the residual variances at 100 d and 150 d were much bigger than at 125d while the genetic variance was the highest at 125d. For RRM-L, heritabilities were 8%, 33%, and 9% at 100 d, 125 d, and 150 d of age. Same estimates were 2%, 26%, and 7% with RRM-S models. Repeatabilities estimated at the three ages were similar (13% to 40% with RRM-L and 9% to 40% with RRM-S). Correlations of 100-125 d, 100-150 d, and 125-150 d of ages were 0.23, -0.07, and 0.66 with RRM-L and 0.39, -0.42, and 0.67 with RRM-S. Adaptation to the feeder in the beginning of test and crowded environment at the end of the test period could cause large residual variances observed in the study. Data from feeder stations can be used for longitudinal analysis of daily gain averaged biweekly. The genetics of daily gain at the beginning and at the end of trail can be different.

Key Words: daily gain, pig, random regression

Dairy Foods: Dairy Products/Chemistry/Enzyme

W63 Calcium reduces DMH-induced large intestinal tumors in male Wistar rats. K. Sivieri*[1] and E. Rossi[2], [1]*Universidade Norte do Paraná-UNOPAR, Londrina, Paraná, Brasil*, [2]*Universidade Estadual Pulista-UNESP, Araraquara, São Paulo, Brasil.*

Different dietary factors can affect colorectal cancer incidence. However, the effect of increased levels of dietary calcium on neoplasms is unclear. The present study was designed to examine the influence of the yogurt fermented with *Enterococccus faecium* CRL and added calcium (600mg/l) on experimental colon carcinogenesis induced by parenteral administration of dimethylhydrazine (DMH). 8-week old rat were given subcutaneous DMH injections at 20 mg/kg once a week during three months. Four groups were used: 1) non-treatment control; 2)DMH control; 3) yogurt fermented with *Enterococcus faecium* CRL 183-DMH plus calcium and induced with DMH (Calcium yogurt) and 4) yogurt fermented *Enterococcus faecium* CRL 183 and induced with DMH (yogurt). Animals were then sacrificed and the incidence of tumors and the number of tumors per tumor-bearing rat were determined. The all groups were compared histologically and TNF-α, IFN-γ and IL-4 cytokines. The non-treatment control not develop tumor. Calcium yogurt group showed a 50% inhibition in incidence in average number of tumors and significantly decreased the number of rats with multiple tumors and TNF-α, IFN-γ and IL-4 cytokines increasing in this group. We conclude that a low dietary calcium supplement in rats inhibits colon cancer carcinogenesis induced by DMH and enhanced the immune response.

Key Words: calcium, yogurt, colon cancer

W64 Effect of storage temperatures on ice cream quality. J. Buyck* and R. Baer, *South Dakota State University, Brookings*.

Ice cream quality is dependant on many factors including the storage temperature. Currently, the industry standard for ice cream storage is -28.9°C (-20°F). Ice cream production costs may be decreased by increasing the temperature of the storage freezer. Increasing the storage temperature of ice cream by one degree may lower energy consumption by about 5%. The objective of this research project was to evaluate the effect of four storage temperatures on storage quality of commercial light and full fat vanilla flavored ice cream. Storage temperatures used were -45.6°C (-50°F), -26.1°C (-15°F), and -23.3°C (-10°F) for the three treatments and -28.9°C (-20°F) as the control. Composition of light and full fat ice cream mixes averaged 5.18 and 10.35% milk fat, 3.99 and 2.98% protein, 0.93 and 0.87% ash, 25.67 and 24.51% total sugars, and 35.77 and 38.71% total solids, respectively. Light and full fat ice cream mixes averaged -2.66 and -2.67°C for freezing point, 6.92 and 6.50 for pH, 0.18 and 0.20% for titratable acidity, respectively. Ice crystal sizes were analyzed by a cold-stage microscope and image analysis at 1, 19.5, and 39 weeks of storage. A trained sensory panel evaluated the coldness intensity, iciness, creaminess, overall body/texture acceptance, storage/stale off-flavor, and overall flavor acceptance of the light and full fat ice creams at 39 weeks of storage. Average ice crystal sizes for light and full fat ice creams after one week of storage were 25.78 and 22.82 um, respectively. In a second study, light and full fat ice creams were heat shocked by storing at -28.9°C (-20°F) for 35 weeks and then alternated between -23.3°C (-10°F) and -12.2°C (10°F) every 24 hours. Heat shocked ice creams were analyzed at 2 and 4 weeks of storage for ice crystal sizes and evaluated by the trained sensory panel.

Key Words: ice cream, storage temperature, ice crystals

W65 Obtention of a dairy ingredient rich in milk fat globule membrane material from whey buttermilk. M. R. Costa*[1,2], R. Jiménez-Flores[3], and M. L. Gigante[2], [1]*Universidade Norte do Paraná, Londrina, Paraná, Brazil*, [2]*Universidade Estadual de Campinas, Campinas, São Paulo, Brazil*, [3]*California Polytechnic State University, San Luis Obispo*.

Milk fat globule membrane (MFGM) components are known for their technological and health properties, and there is interest in isolating and concentrating this material from dairy sources. Whey buttermilk contains triglycerides residues and hydrosoluble compounds from milk, including MFGM material, and it can be considered a suitable source of the latter. The objective of this work was to obtain a dairy ingredient rich in MFGM components from whey buttermilk using membrane filtration. Batches of sweet whey cream was obtained from a commercial source and churned into whey butter with resulting separation of whey buttermilk. The buttermilk was processed through an ultrafiltration (UF)/diafiltration (DF) system (10 KDa molecular weight cutoff) at 25 °C and 6 bar of transmembrane pressure and the final retentate was spray-dried. The whey buttermilk, the filtration retentates, and the whey buttermilk powder (WBP) were analyzed for composition, protein profile and phospholipids content. All the experiments were done in triplicate. The protein, lipid, phospholipid, lactose and ash contents in the whey buttermilk, in dry matter basis, were 24.9, 16.3, 2.0, 51.8 and 7.0%, respectively. The average transmembrane flux was 34 and 30 L.h-1.m-2 during UF and DF, respectively. The membrane filtration reduced the contents of lactose and ash in 94 and 77% ($p<0.05$), and increased the contents of lipids, phospholipids and proteins in 190, 90 and 300%, respectively ($p<0.05$). The final composition of the WBP was 47.4, 47.3, 7.2, 3.0 and 2.3% of protein, lipid, phospholipids, lactose and ash, respectively. SDS-PAGE showed small casein content in the whey buttermilk and that MFGM proteins represented large amount of the total protein in the whey buttermilk powder. The use of whey buttermilk as raw-material and the application of ultrafiltration and diafiltration yield a dairy ingredient with original features for its use in foods, especially considering that the powder had a protein:lipid ratio of 1:1, and high content of phospholipids.

Key Words: membrane filtration, supercritical fluid extraction, phospholipids

W66 Effect of pH on functional properties of regular and whey buttermilk powders. M. R. Costa*[1,2], R. Jiménez-Flores[3], and M. L. Gigante[2], [1]*Universidade Norte do Paraná, Londrina, Paraná, Brazil*, [2]*Universidade Estadual de Campinas, Campinas, São Paulo, Brazil*, [3]*California Polytechnic State University, San Luis Obispo*.

Buttermilk is a derivative product of butter production from cream. However, butter can also be produced from a by-product of cheese, the whey cream. The buttermilk produced from whey cream has been poorly characterized. The objective of this work was to evaluate the effect of pH on some functional properties of regular and whey buttermilk powders. Whey buttermilk powder was produced by ultrafiltration and 5X diafiltration (membrane of 10 KDa molecular weight cutoff, at 25 °C) of whey buttermilk followed by spray-drying of the final retentate. The regular buttermilk was a commercial powder. Protein solubility (5% protein solution), by the centrifugation method, and emulsion stability (20% canola oil and 1% protein emulsions), by creaming index and kinetics (QuickScan® optical analyzer), were evaluated at pH 5 and pH 7 for both powders. The pH did not significantly affect the protein solubility of the whey buttermilk solutions while the regular buttermilk solutions had its protein solubility reduced from 86.2 to 73.0% when the pH was decreased from 7 to 5. This protein solubility decrease was possibly due to the reduction of the residual casein solubility, found in higher quantity in the regular buttermilk than in whey buttermilk. At pH 7, regular and whey buttermilks showed similar protein solubility, while at pH 5 the whey buttermilk had the best solubility. The pH significantly affected the emulsion stability of the whey and regular buttermilk solutions. At pH 5, the emulsions made from both buttermilk powders had lower stability (creaming index ~ 38%) than at the highest pH. At pH 7, the whey buttermilk emulsion showed the best stability (creaming index of 0.2%) in comparison to the regular buttermilk (creaming index of 3%). Whey buttermilk powder showed better functionality than the regular buttermilk powder, which makes it an interesting ingredient to be used in food formulations as high quality protein and lipid sources, especially in low pH foods.

Key Words: protein solubility, emulsion stability, dairy ingredients

W67 Milk iodine concentration in goats supplemented with potassium iodide. A. Nudda*[1], F. Aghini-Lombardi[2], G. Battacone[1], M. Decandia[3], M. Frigeri[2], and G. Pulina[1,3], [1]*Dipartimento di Scienze Zootecniche, University of Sassari, Italy*, [2]*Dipartimento di Endocrinologia e Metabolismo, University of Pisa, Italy*, [3]*Agricultural Research Agency of Sardinia - AGRIS Sardegna, Sassari, Italy*.

Aim of this work was to evaluate the effects of continuous oral supplementation of potassium iodide (KI) on iodine levels in goat milk. Thirty crossbreed dairy goats were divided into 3 groups and each goat was supplemented with 0 (control; group 0), 450 (group 1), or 900 (group

2) µg of KI/day. The dose of KI (76.5% of Iodine) was orally administered in water every day for 8 weeks. Milk yield was recorded and milk samples were collected weekly. Iodine concencentration was determined using the Sandell–Kolthoff reaction. Data were analyzed with a GLM procedure including iodine level, week and their interaction in the model. Milk yield was not influenced by KI supplementation and averaged 1229, 1227 and 1179 g/d per head in groups 0, 1 and 2 respectively. Mean milk iodine concentrations throughout the experimental period (90 days) were 60.1 ± 50.5, 78.8 ± 55.4 and 130.2 ±62.0 µg/l in groups 0, 1 and 2, respectively. The extent of enrichment of iodine concentration in milk was about 31% in group 1 and 117% in group 2 compared to control. Milk iodine concentration within group showed a high variability among weeks, especially in the group that received the highest dose of KI. The carry-over (iodine excreted in milk/iodine supplemented), which averaged 32% in group 1 and 24% in group 2, was lower than the values previously reported in other ruminant species.

Key Words: milk, iodine, dairy goat

W68 Antioxidant properties of milk protein dispersions preheated with various sugars. H. J. Giroux*, J. Houde, and M. Britten, *Food Research and Development Centre, Agriculture and Agri-Food Canada, Saint-Hyacinthe, QC, Canada*.

Polyunsaturated fatty acids are susceptible to oxidation during heating. It has been shown that sterilization induced significant oxidative degradation in dairy beverages enriched with linseed oil. Nevertheless, during storage, sterilized beverages showed better resistance to photo–oxidation than unheated beverages probably as a result of the antioxidant activity of Maillard reaction products generated during heating. The objective of this study was to evaluate the effect of adding preheated milk protein–sugar dispersions to dairy beverages (enriched with linseed oil) in order to prevent oxidation during sterilization. Milk protein (MP) dispersions (3.5% protein) containing various concentrations of glucose–galactose (GG), glucose–fructose (GF) or sucrose (S) were heated at 110°C for 10 minutes. The preheated protein–sugar dispersions were added to dairy beverage formulations at 5% (v/v). Unheated protein–sugar dispersions were also tested. Color and hydroxymethylfurfural (HMF) content were measured to evaluate the extent of Maillard reaction. Propanal and hexanal (two volatile secondary oxidation products) were selected as indicator for linseed oil oxidation and analysed by GC–MS. The total colour difference (ΔE) and HMF content of the beverages increased (P<0.01) with increasing concentration of unheated or preheated MP–GG and MP–GF preparations, the effect being significantly higher in beverages containing preheated preparations. Unheated protein–sugar preparations did not reduce lipid oxidation during sterilization while preheated MP–GG and MP–GF preparations were most effective. The concentrations of hexanal and propanal resulting from the sterilization treatment were respectively reduced by 100 and 78% when GG or GF concentration in the beverage was 0.4%. The addition of preheated MP–S had no significant effect on color, HMF content or sterilization–induced oxidation. In conclusion, milk protein dispersion preheated in the presence of monosaccharide mixtures can be added to dairy beverages to efficiently inhibit oxidation during sterilization treatment.

Key Words: oxidation, sterilization, Maillard

W69 Main phospholipids content of sweet whey cream, butter and buttermilk. M. R. Costa*[1,2], R. Jiménez-Flores[3], and M. L. Gigante[2], [1]*Universidade Norte do Paraná, Londrina, Paraná, Brazil*, [2]*Universidade Estadual de Campinas, Campinas, São Paulo, Brazil*, [3]*California Polytechnic State University, San Luis Obispo*.

There is an increasing interest in phospholipids found in milk because of their technological functionality and potential health benefits. Whole milk has around 0.04% of phospholipids, of which distribute approximately 35% in the whey and 65% in the milk fat globule membrane (MFGM). When whey cream is churned into butter, an aqueous phase called whey buttermilk is separated. These products contain all the milk components, including MFGM material. The objective of this work was to quantify in sweet whey cream, butter and buttermilk the contents of the main phospholipids found in milk and dairy products: phosphatidylcholine (PC), phosphatidylethanolamine (PE), sphingomyelin (SM), phosphatidylinositol (PI) and phosphatidylserine (PS). Batches of sweet whey cream were taken from a commercial cheese plant and churned to obtain whey butter and buttermilk. The three products had their gross composition evaluated. The fat extracted from these samples was analyzed by High Performance Liquid Chromatography to identify and quantify their main phospholipids contents. The protein, lipid, phospholipid, lactose and ash contents, in dry matter basis, were, respectively, 3.6, 86.1, 4.9, 6.4 and 3.9% for the whey cream, 0.6, 96.9, 5.1, 2.4 and 0.1% for the whey butter, and 24.9, 16.3, 2.0, 51.8 and 7.0% for the whey buttermilk. As expected, the main phospholipids found were phosphatidylcholine, phosphatidylethanolamine and sphingomyelin, followed by phosphatidylinositol and phosphatidylserine. As a percentage of the total lipids, PC, PE, SM, PI and PS contents were, respectively, 1.90, 1.00, 1.23, 0.87 and 0.64% for the whey cream; 1.77, 0.94, 1.16, 0.84 and 0.61% for the whey butter; and 5.71, 2.11, 2.69, 0.88 and 1.00% for the whey buttermilk. These phospholipids represented 5.6, 5.3 and 12.4% of the total lipids in the whey cream, butter and buttermilk, respectively, showing that this class of lipids distributes preferentially to the aqueous phase. The relatively high phospholipids content makes the whey buttermilk interesting to be processed in a dairy ingredient that would be rich in compounds with good functionality and potential health benefits.

Key Words: milk fat globule membrane, dairy ingredients, chromatography

W70 Expression of milk-derived angiotensin-converting-enzyme-inhibiting peptide in *Lactococcus lactis*. X. Han[2], L. Yao[2], M. Wang[2], D. Sun[2], B. Li[2], and Y. Jiang*[1,2], [1]*National Dairy Engineering & Technical Research Center, Northeast Agricultural University, Harbin, China*, [2]*Key Laboratory of Dairy Science, Ministry of Education, Northeast Agricultural University, Harbin, China*.

Peptides derived from milk proteins can have Angiotensin-converting enzyme (ACE)-inhibiting properties and may thus be used as antihypertensive components. The objective of this study is to establish a new method to produce antihypertensive peptides (AHP) by DNA recombination technology in *Lactococcus lactic*. To produce a large quantity of the ACE-inhibiting peptide CEI_7, which consists of seven amino acids found from β-casein f(169-175), a high-level expression was explored with tandem multimers of CEI_7 gene in *Lactococcus lactic* . The genes encoding CEI_7 were tandemly multimerized to 4-mers, in which each of the repeating units in the tandem multimers was connected to the neighboring genes by a DNA linker encoding Ile-Glu-Gly-Arg for the cleavage of multimers by Factor Xa. The repeats gene was cloned into the expression vector pNZ8148, and expressed in *Lactococcus lactic* NZ9000 with nisin induction. Then the tandem multimers mRNA expression identified and the optimal induction-condition obtained by real time RT-PCR. Finally, using the protocol of protein electrophoresis

and Western Blot completes the further validation. The 4-mer's mRNA had completely expressed. Optimization of induction factors for this pNICE system was that the induction was caring out at the early exponential phase (2h after bacterial inoculation) by 2 ng/ml nisin, and the best time for analyzing the gene product after induction was the 1st h. At last, SDS-PAGE and Western Blot analyses showed the expressed protein, with a molecular weight of about 8kD, which was close to the 4-mer's theoretical molecular weight and had same immunogenicity. The aim of expression was came true, but the yield of the recombinant CEI_7 was lower than expectation causing the mRNA of tandem multimers being unstabilized.

Key Words: angiotensin-converting-enzyme-inhibiting peptide, expression, *Lactococcus lactis*

W71 Effect of tara gum and carrageenan addition on syneresis of non-fat set yogurt. C. L. Hatanaka, A. L. Cavallieri, R. L. Cunha, and M. L. Gigante*, *Universidade Estadual de Campinas*, *Campinas, SP, Brazil*.

The aim of this work was to evaluate the effect of tara gum and carrageenan addition on spontaneous syneresis during the cold storage. Three types of yogurts with 12.5% of dry matter, made of skim reconstituted milk, were manufactured: (1) yogurt control (no polysaccharides added); (2) yogurt with 0.02% of tara gum and (3) yogurt with 0.02% of tara gum and 0.02% of carrageenan. Solutions of polysaccharides and skim milk in distilled water were prepared at 85°C/30 min, cooled and stored (5°C) a day before the fermentation. The mixtures were inoculated with 2.5% of starter culture (*Streptococcus thermophilus* and *Lactobacillus bulgaricus*), and the fermentation was conducted at 45°C until pH 4.7±0.05. Total solids, protein, fat, ash and lactose content of yogurts were evaluated a day after the manufacturing. Spontaneous syneresis was evaluated during the cold storage at 1, 8, 15, 22 and 29 days after yogurt manufacture. A split-plot design with three replicates was used. The treatments did not affect the yogurt composition, which was 12.3±0.1% of total solids; 4.36±0.02% of protein; 0.098±0.001% of fat; 1.07±0.01% of ash and 6.43±0.09% of lactose. Treatments significantly affected yogurts syneresis. Yogurt with tara gum and carrageenan showed the lowest syneresis, followed by yogurt control and then by yogurt manufactured with tara gum. The highest syneresis observed when tara gum was added was probably due to depletion or excluded volume interactions among this polysaccharide and the casein, which may weakened the gel structure. The lowest syneresis in the yogurt containing tara gum and carrageenan may be due to an increase of system hydrophilic groups caused by the presence of the polysaccharides, which confers greater interactions among water and biopolymers segments. The addition of polysaccharides also led to casein and carrageenan interactions below the casein isoelectric point, since at these conditions they associate with each other and strengthen gel structure allowing an additional immobilization of water in the yogurt network.

Key Words: hydrocolloids, set yogurt, syneresis

W72 Improvement of emulsifying properties of sodium caseinate by conjugation with maltodextrins through the initial step in the Maillard reaction. Y. Lu* and J. Lucey, *University of Wisconsin*, *Madison*.

The objective of this study was to improve the emulsifying properties (e.g., stability) of sodium caseinate (SC) by conjugation with maltodextrin (MD) in an aqueous solution through the initial step in the Maillard reaction (by the method of Zhu et al. 2008. J. Agric. Food Chem. 56: 7113). Complexation was conducted in phosphate buffer using SC and MD and by varying the reaction conditions including: temperature (60-90°C), pH (6.5 to 8.5), reaction time (0-180 min), and solids content (9 to 19%, w/w). Conjugation was monitored using Difference UV (DUV) Spectroscopy by the formation of a peak at around 305 nm; conjugate formation was confirmed using SDS-PAGE with both protein and glycoprotein stains. Yellow color development (unwanted) was monitored using DUV spectroscopy as indicated by an increase in absorbance at λ450 nm. Conjugate formation increased with longer reaction time, and higher solids content, or temperature. There was no significant difference in conjugate formation between different pH values investigated. Emulsifying properties of the conjugates were determined using a particle size analyzer and the surface-weighted mean particle size, D[3,2], was measured. Compared to emulsions made with SD alone, the D[3,2] values of emulsions made with SD-MD conjugates were smaller at both the 1st day after manufacture and after storage at 4°C for 30 days. These results indicate that stability of SD emulsions was improved by conjugation with MD. This study could be significant in the development of a new type of food ingredient.

Key Words: sodium caseinate, protein-polysaccharide conjugates, emulsifying properties

W73 Chemical composition, probiotic survivability and sensory property of goat's milk kefir. Y. H. Bao[1,2], G. P. Yu[1,3], and M. R. Guo*[1], [1]*University of Verment*, *Burlington*, [2]*Northeast Forestry University*, *Harbin, Heilongjiang, China*, [3]*Northeast Agricultural University*, *Harbin, Heilongjiang, China*.

Kefir is an acidic and mildly fermented dairy product and considered as a functional food. As a specialty food, goat's milk and its products are getting popular in the U.S. In present study, formulation and processing technology of goat's milk kefir were developed using a commercial starter containing *L. lactis subsp. lactis* and *L. lactis subsp. diacetylactis* and probiotics *L. casei* and *L. plantarum*. Three different flavored kefir beverages were analyzed for chemical composition, changes in pH and viscosity, and probiotic survivability during storage. Mold, yeast and coliform counts were also evaluated weekly for these samples. The gross compositions of three products (blueberry, strawberry and plain) were: total solids: 16.28%, 14.78% and 16.03%; protein: 2.43%, 2.16% and 2.35%; fat: 1.99%, 1.87% and 2.15%; ash: 0.62%, 0.58% and 0.61%, respectively. There were no considerable changes in pH and viscosity during the 8-week storage at 4°C. Both *L. casein* and *L. plantarum* remained viable and their populations were above 10^6 cfu/g during storage. The mold, yeast and coliform were not detected in the products. The results showed that the addition of fruit flavor had no considerable effect on the probiotic survivability, coliform, and viscosity during the storage. The results of sensory evaluation showed that the fruit-flavored goat's milk kefirs were stable without losing its desired flavor qualities.

Key Words: goat's milk, kefir, probiotics

W74 Optimizing the organoleptic and nutritional qualities of a dairy-based ready-to-eat food product. J. Heick*, M. Cleveland, H. Khalil, and R. Jiménez-Flores, *California Polytechnic State University*, *San Luis Obispo*.

Providing high quality dairy protein in a ready-to-eat (RTE) form is desirable when delivering convenient nutrition to active consumers

as well as providing probiotic organisms as a functional component. The main challenge in developing such a product is the relatively high concentration of protein, which negatively impacts flavor, texture and overall acceptability throughout the product shelf life. Another challenge is the survival of active probiotic organisms, limited by relative instability of organisms in processed foods. We have developed a unique formulation and processing technique that eliminates the unappealing dense texture of high protein food, while extending the products' shelf life. The optimized RTE delivers a minimum of 25 grams of protein per serving. It includes milk phospholipids, which have been shown to enhance the survival of probiotic lactic acid bacteria (LAB). Our experimental design was a 2 x 2 x 3 factorial experiment that included two processing methods; freeze drying and vacuum drying; two levels of dairy ingredients; buttermilk powder (BMP) rich in milk phospholipids and skim milk powder (SMP); and three strains of LAB. Our results show that drying the RTE below five percent moisture results in a clean tasting lightweight energy-dense product. Results indicated that the impact of the drying method on flavor and texture profiles was not significant, the final moisture being the most important factor. In addition enumeration of the probiotic organisms displays a two to three log reduction after processing with a difference of one log between the two methods. Statistical analysis of the various formulations and drying parameters show that the BMP and freeze-drying combination produces the most acceptable product in terms of flavor, texture, and probiotic survival.

Key Words: probiotics, freeze drying, phospholipids

W75 Milk fatty acid composition of whole fluid milk in the United States. A. M. O'Donnell*, D. M. Barbano, and D. E. Bauman, *Cornell University*, *Ithaca, NY*.

Consumers are increasingly aware that food components have the potential to influence human health maintenance and disease prevention, and dietary fatty acids (FA) have been of special interest. It has been 25 years since the last survey of US milk fatty acid composition, and during this interval there have been substantial changes in dairy rations, including increased use of total mixed rations and by-product feeds as well as the routine use of lipid and FA supplements. Furthermore, analytical procedures have improved allowing greater detail in the routine analysis of FA, especially *trans* fatty acids. Our objective was to survey US milk fat and determine its fatty acid composition. We obtained samples of fluid milk from 56 milk processing plants across the US every 3 months for one year to capture seasonal and geographical variations. Processing plants were selected based on the criteria that they represented the major volume of milk produced in that area. An overall summary of the milk fat analysis indicated that saturated fatty acids (SFA) comprised 63.7% of total milk FA with palmitic and stearic acids representing the majority (44.1% and 18.3% of total SFA, respectively). Unsaturated fatty acids (UFA) were 33.2% of total milk FA with oleic acid predominating (71.0% total UFA). *Trans* FA (TFA) represented 3.2% of total FA, with vaccenic acid being the major *trans* isomer (46.6% total TFA). *Cis*-9, *trans*-11 18:2 conjugated linoleic acid represented 0.56% total milk FA, and the major omega-3 FA (linolenic acid, 18:3) composed 0.39%. Analyses for seasonal and regional effects indicated statistical differences for some FA, but these were minor from an overall human nutrition perspective as the FA profile for all samples were numerically similar. Overall, the present study provides a valuable database for current fatty acid composition of US fluid milk, and results demonstrate that the milk fatty acid profile is remarkably consistent across seasons and geographic regions from the perspective of human dietary intake of milk fat.

Key Words: fatty acids, milk fat composition, survey

W76 Shelf life of milk. C. A. Boeneke*, J. L. Vargas, and K. J. Aryana, *Louisiana State University Agricultural Center*, *Baton Rouge*.

The objective of this work was to assess the shelf life of milk. Whole and two percent milks were received from 17 dairy processing plants located in the west, midwest, and southern regions of the U.S in duplicate. All milks were shipped overnight in styrofoam coolers filled with ice to maintain the temperature of the samples. The samples were pasteurized at the processing plants by high-temperature short-time pasteurization. The first set of milk samples was evaluated for standard plate count, coliforms, and psychrotrophic counts (using a standard method as well as a rapid method), heat-resistant spore-forming psychrotrophs, aerobic spores, HR testing (HR-1, HR-2 and HR-3), fat percentage, protein percentage, somatic cell count and sensory evaluation. Milks were evaluated for flavor using the Collegiate Dairy Products Evaluation Score Sheet. The duplicate set was evaluated for standard plate count, coliform count and a sensory evaluation at the end of two weeks storage time at seven degrees C. Three replications were conducted. Five percent of the 2% milk samples presented psychrotrophic counts (three samples in the first replication of the study, two samples in the third replication) with a mean values of approximately 2 CFU (colony forming units)/ml. For heat resistant spore forming psychrotrophs, ten percent of the samples showed the highest counts of approximately 1 CFU/ml, mainly in the second replication of the study. Ninety percent of the samples showed zero counts. Sensory evaluation scores ranged from 1 to 10 out of 10 possible points. The most common flavor criticism found by the panelists was a cooked off-flavor as well as rancid and oxidized criticisms.

Key Words: shelf life, fluid milk

W77 Influence of resistant starch on the characteristics of fat free plain yogurt. M. Moncada[1], K. Aryana*[2,1], M. Keenan[2,1], R. Martin[2,1], F. Greenway[3], and N. Dhurandhar[3], [1]*Louisiana State University*, *Baton Rouge*, [2]*Louisiana State University Agricultural Center*, *Baton Rouge*, [3]*Pennington Biomedical Research Center*, *Baton Rouge, LA*.

Resistant starch is a starch that escapes digestion in the small intestine and can deliver some benefits of insoluble and soluble fiber. Objective was to study the influence of resistant starch on the physico-chemical, microbiological and sensory characteristics of yogurt. Three types of resistant starches namely; Hi maize, Amioca, and Novelose were incorporated at 30 g per 8 oz of yogurt. Total solids in the control were kept constant with non fat dry milk. Apparent viscosity, pH, syneresis, sensory properties (flavor, body and texture, and appearance and color), lactic acid bacterial counts and color (L*, a*, and b*) of yogurts were determined at 0, 1, 3, 5 and 7 week after yogurt manufacture. Yogurts with Amioca had significantly the lowest apparent viscosity values, while there were no significant difference among the other yogurts. Yogurts with Hi maize and Novalose had significantly the highest syneresis which were not different from each other. The pH values of the yogurts with the resistant starches were significantly lower compared to the control but were not different compared to each other. Control and yogurts with Amioca had significantly the highest flavor scores compared to the other yogurts. Control had significantly the highest sensory body texture

score compared to the other yogurts. Body and texture scores of yogurts with resistant starches were not significantly different from each other. Control and yogurts with Amioca had significantly the lowest a* values which were not different from each other, while yogurts with Hi maize and Novalose had significantly the highest a* values which were not different from each other. Control had significantly the highest b* values, while yogurts with Amioca had significantly the lowest b* values. Type of resistance starch influenced different characteristics of yogurt.

Key Words: resistant starch, fermented, yogurt

W78 Acceptability of yogurt containing resistant starch. K. Aryana*[1,2], D. Olson[2], M. Keenan[1,2], R. Martin[1,2], F. Greenway[3], and N. Dhurandhar[3], [1]*Louisiana State University Agricultural Center*, *Baton Rouge*, [2]*Louisiana State University*, *Baton Rouge*, [3]*Pennington Biomedical Research Center*, *Baton Rouge, LA*.

Objective was to study the acceptability of yogurt containing Hi maize resistant starch. Resistant starch (RS) Hi maize was incorporated in yogurt manufacture at 30 g per 227 g of yogurt. Total solids in the control were kept constant with non fat dry milk. One hundred participants (without allergy to dairy or starch) used a 9-point hedonic scale (1=dislike extremely; 5 = neither like nor dislike; 9 = like extremely) for overall liking, appearance, color, aroma, taste, thickness, graniness, product acceptability. Yogurt with or without RS was placed in separate 85g cups which were assigned 3-digit random number codes. The sensory data were analyzed using the GLM procedure of SAS 9.1 for Windows as a Randomized Block Design using participants as blocks. There were no significant ($P > 0.05$) differences in appearance, color and aroma scores for the control yogurt compared to the RS yogurt. Taste, thickness, graininess and likeness scores for the control yogurt were significantly ($P < 0.0001$) higher than the RS-yogurt. The RS-yogurt was acceptable to the consumers.

Key Words: resistant starch, yogurt, acceptability

W79 Improving the quality of yogurt with modified whey protein ingredients. P. T. Matumoto-Pintro*, L. Rabiey, G. Robitaille, and M. Britten, *Agriculture and Agri-Food Canada*, *St-Hyacinthe, QC, Canada*.

Fermented milk products are widely consumed as healthy food, and represent a growing market for the dairy industry. Denatured whey protein concentrates or isolates are used in yogurt formulations to decrease costs, improve nutritional value or reduce syneresis. However, high concentrations of whey protein usually results in unpleasant elastic textures. In order to increase the viscous character of yogurts supplemented with denatured whey protein, alteration of composition (increased proportion of α–lactalbumin) and proteolytic treatment (using α–chymotrypsin) of whey protein isolate were studied. Whole milk was standardized to 4.2% protein with heat–treated whey protein isolates, or milk protein concentrate as a control. The proportion of α–lactalbumin in the whey protein isolate and the degree of hydrolysis were the main factors under study. Rheological properties, rate of sedimentation and syneresis were monitored on set–style and stirred–style yogurts during a three weeks storage period. Controlled protein hydrolysis and increasing proportion of α–lactalbumin in the whey protein isolate reduced the stress and the deformation at rupture point in set–style yogurts, bringing the rheological characteristics close to those of control yogurt. Similar trend was observed for stirred–style yogurts. High proportion of α–lactalbumin and hydrolysis treatment also reduced yogurt particles sedimentation rate, suggesting a finer structure, less prone to syneresis. In conclusion, this study showed that the modification of whey protein composition or appropriate hydrolysis treatment can be used to improve the texture attributes of set–style and stirred–style yogurts.

Key Words: yogurt, α-lactalbumin, proteolysis

W80 Effect of starch spherulites on survival of bifidobacteria in the presence of acid or bile. S. Chittiprolu, R. F. Roberts*, and G. R. Ziegler, *The Pennsylvania State University*, *University Park*.

Strains of the genus Bifidobacterium are widely added to ferment dairy products such as yogurt because of their potential probiotic activity. Bifidobacteria are often sensitive to stresses encountered during production and storage of food and during passage through the gastrointestinal tract. The objectives of this study were to develop conditions for production of starch-based spherulites, to determine if bifidobacteria adhere to spherulites and to determine if adhesion to spherulites could improve their survival when exposed to acid or bile. First, conditions were developed to produce starch-based spherulites successfully in a pressure vessel using purified potato amylose. These spherulites were further dried, characterized and stored until adequate quantities were obtained for use in adhesion and survival studies. A total of 38 Bifidobacterium strains were analyzed for their ability to adhere to potato amylose spherulites and native high amylose maize starch granules (Hylon VII). The strains differed in their ability to adhere to spherulites and Hylon VII with adhesion to spherulites significantly higher than Hylon VII for the majority of the strains. The protective effect of adherence of 4 bifidobacterial strains to spherulites or Hylon VII on their survival when exposed to acid or bile was investigated. The number of bifidobacteria surviving after 3 h exposure to acid (pH 1.8, 2.9 and 7.2) or bile (0 and 0.5% oxgall) was significantly affected by type of strain used, pH and bile concentration. The strains analyzed were not tolerant to pH 1.8 but survived well at pH 2.9 and 7.2 and in bile solutions containing 0 and 0.5% oxgall. Overall, adhesion to spherulites or Hylon VII did not improve the survival of bifidobacteria in the presence of acid or bile. This is the first study on protective effects of spherulites on survival of bifidobacterial strains.

Key Words: bifidobacteria, spherulites, adhesion

W81 Determination of free fatty acid profiles of reduced-fat and whole goat milk cheeses aged for 3 months under refrigeration. W. Nouira[1], Z. Guler[2], and Y. W. Park*[1], [1]*Fort Valley State University*, *Fort Valley, GA*, [2]*Mustafa Kemal University*, *Hatay, Turkey*.

Implication of dietary fat with coronary heart diseases, strokes and other health concerns has increased the demand for reduced-fat dairy products. Few reports are available for free fatty acid profiles of reduced fat goat milk products. The study was conducted to evaluate differences in free fatty acid (FFA) compositions between skim milk (SM) and whole milk (WM) goat cheeses aged at 4°C for three months. The two types of cheeses were manufactured using a bulk goat milk from a mixed herd of Saanen, Alpine, and Nubian breeds. Cream was separated from the whole milk by a cream separator (Model 17584, Clair Co., Austria) before manufacture of SM cheeses. FFAs of all cheeses were extracted in diisoprophyl ether using polypropylene chromatography column (Bio-Rad Labs, Los Angeles, CA), and FFA concentrations were quantified using a gas chromatography (17A-GC, Shimadzu Co., Japan) equipped

with a fused silica capillary column (DB-FFAP; 30 m x 0.25 mm i.d. x 0.25 Î¼m, Agilent Technologies, Wilmington, DE). FFA contents (mg/g cheese) of fresh WM and SM cheeses for C4:0, C6:0, C8:0, C10:0, C12:0, C14:0, C16:0, C18:0, C18:1, C18:2 were: 0.020, 0.072; 0.070, 0.035; 0.061, 0.055; 0.181, 0.167; 0.073, 0.047; 0.174, 0.112; 0.579, 0.152; 0.308, 0.202; 0.521, 0.174; 0.057, 0.026, respectively. The respective % FFA in total fatty acids for 0, 1 and 3 months aged WM and SM cheeses were 8.44, 12.4; 6.31, 16.91; 12.03, 14.19, indicating that the reduced-fat cheeses had significantly higher proportions of FFA than those in the corresponding WM cheeses. The respective ratios of SM:WM cheeses in FFA concentrations for 0, 1 and 3 months aging were 0.48, 1.21 and 0.364, suggesting that SM cheeses had higher levels of FFA than WM cheeses. The higher proportions of FFA in SM cheeses compared to WM counterparts may account for the released FFAs from the fat globule membrane during cream separation.

Key Words: goat cheese, reduced-fat, free fatty acids composition

W82 Heat stability of mixtures of different milk protein concentrates (40–90% protein) and whey protein concentrate (80% protein). Y. H. Yong* and E. A. Foegeding, *Department of Food, Bioprocessing and Nutrition Sciences, North Carolina State University, Raleigh*.

Meal replacement beverages generally contain a mixture of proteins that are at neutral pH and processed by retorting. Low heat stability of whey protein ingredients limits their application in these products. The goal of this investigation was to determine if combining whey protein concentrate 80 (WPC80, containing minimum 80% w/w dry basis protein) at a proper ratio with milk protein concentrate (MPC) will improve heat stability and thereby allow for a higher percentage of whey proteins in these beverages. Five types of MPC (containing 40, 56, 70, 80 and 90% w/w dry basis protein) and four types of WPC80 (regular types A, B, C and heat stable/gelling type H) were collected from U.S. companies. At pH 7, single protein solutions of WPC80 (4–10% w/v protein), MPC (5–12.5% w/v protein) and their mixtures (particularly WPC80 and MPC80) at different ratio (10% w/v total protein) were retorted for 26±1 min (including sterilized at 121+2°C for 10 min). For single WPC80 solutions, all four types of WPC80 showed different thermal stabilities. The two most stable samples, WPC80-A and H, formed gels at 9 and 7% w/v protein, respectively. WPC80-A, B and C showed similar destabilizing trends from stable fluids, to fluid aggregates, to gels, with increasing protein concentrations. In the case of MPC solutions, MPC-40 and 56 gelled at 7.5 and 12.5% w/v protein, correspondingly, but MPC-70, 80 and 90 remained stable at 12.5% w/v protein. Mixtures of WPC80 and MPC80 at 10% w/v total protein improved the heat stability of WPC80-A, B and C but, surprisingly not WPC80-H. When ratios of WPC80-A to MPC80 were 7:3 or lower, all the mixtures remained as stable fluids after thermal processing. Viscosity of the retorted solutions became higher when the concentration of WPC80-A in the mixtures increased. The results showed that at 10% w/v protein, up to 70% of MPC80 can be replaced with a WPC80 and still produce a stable fluid after retorting.

Key Words: milk protein concentrate, whey protein concentrate, heat stability

W83 Effect of processing on the structure and functional properties of milk phospholipids. S. Gallier*[1,2], D. Gragson[3], D. W. Everett[1], and R. Jiménez-Flores[2], [1]*Department of Food Science, University of Otago, Dunedin, Otago, New Zealand*, [2]*Dairy Products Technology Center, California Polytechnic State University, San Luis Obispo*, [3]*Department of Chemistry and Biochemistry, California Polytechnic State University, San Luis Obispo*.

Bovine raw milk is a very nutritious food, however consumers are concerned about any health benefit derived from consumption of this product. There are many questions about whether current processing conditions, such as pasteurization, have benefits other than microbiological safety. One of the components of milk that has been associated with several biological functions is milk fat, and in particular, the milk fat globule membrane (MFGM). In this study, we compared phospholipids from bovine raw milk, raw cream, whole homogenized pasteurized milk and buttermilk powder. The basis for our comparative study is the physical and structural properties of the phospholipids from each of these products. We used a combination of Langmuir trough studies, atomic force microscopy and confocal laser scanning microscopy to probe the changes in function and structure due to processing (centrifugation, homogenization, pasteurization and churning). By studying the behaviour of phospholipids using these techniques, when MFGM proteins are added to the mixture, our study has the potential to improve our understanding of the structure, dynamics, and composition of the lipid domains of the MFGM. The phospholipids were obtained by solid-phase extraction from each dairy product. The Langmuir film balance mounted on an epifluorescence microscope was used to characterize the physical behaviour of the phospholipid monolayer films and the coexistence of different phases within these films. We have evidence that the shape and size of the lipid domains vary according to the temperature of the trough, the pressure applied to the monolayer, but most importantly, the properties differ according to the milk product source of the phospholipids. Multilamellar and large unilamellar vesicles were also made from these phospholipids and observed under a confocal laser scanning microscope to compare their morphology and structure to the native MFG. We are confident that this information will help scientists and technologists to decide how to best process milk to keep valuable biological functionality.

Key Words: milk phospholipids, monolayer, dairy processing

W84 Investigation of self-assembly properties of a β–lactoglobulin tryptic peptide. M.-M. Guy*[1,2], M. Tremblay[3], N. Voyer[3], S. Gauthier[1,2], and Y. Pouliot[1,2], [1]*Institute of Nutraceuticals and Functional Foods (INAF), Quebec City, QC, Canada*, [2]*Dairy Science and Technology Research Center (STELA), Quebec City, QC, Canada*, [3]*Protein function, Structure and Engineering Research Center (CREFSIP), Quebec City, QC, Canada*.

Tryptic hydrolysis of β–lactoglobulin (β–lg) generates a number of peptides having specific functional and biological properties. Spontaneous peptide precipitation has been observed during the concentration of a tryptic hydrolysate of β–lg by reverse osmosis (RO). The analysis of the insoluble fraction has allowed the identification of β–lg N-terminal fragment 1—8 as the major peptide involved in the formation of aggregates. Structural analyses showed that peptide β–lg f1—8 forms aggregates via an efficient self-assembly process. Nanostructures formed by self-assembly of peptide β–lg f1—8 were observed by transmission electron microscopy (TEM). Circular dichroïsm (CD) characterization of the secondary structure of peptide β–lg f1—8 showed significant changes in the secondary structure of the peptide which can adopt β–sheet or random coil conformations under specific conditions. Self-assembly properties of the peptide β–lg f1—8 are triggered by some key parameters such as pH, peptide concentration, ionic strength and solvent polarity. The self-assembly properties of peptide β–lg f1—8 suggest that this peptide

could be suitable for biomedical applications. Moreover, the study of aggregation of peptide β–lg f1—8 is providing new clues for the development of large-scale methods of peptide purification using membrane separations (RO) under specific physicochemical conditions.

Key Words: β–lactoglobulin, peptides, self-assembly

W85 Identification of chemical components responsible for cardboard flavor in whey proteins. M. E. Whitson*, R. E. Miracle, and M. A. Drake, *North Carolina State University*, *Raleigh*.

Off flavor of whey proteins is a major obstacle to widespread utilization. Cardboard flavor is one of the most commonly described off-flavors. Precise knowledge of the volatile compounds that cause cardboard flavor is still not known. The objective of this research was to identify volatile components responsible for cardboard flavors in whey protein concentrates and isolates (WPC, WPI). Actual cardboard and brown paper samples (n= 5 types) were soaked in deionized water and analyzed by headspace solid phase micro extraction with gas chromatography mass spectrometry (SPME GC-MS) and descriptive sensory analysis. An array (n= 60) of stored (> 12 mo) and fresh (< 2 mo) WPC and WPI were rehydrated and evaluated by sensory analysis and SPME GC-MS. Univariate and multivariate analyses were applied to identify volatile compounds associated with cardboard flavor. Subsequently, sniff jars were created for potential cardboard compounds using pure chemical standards and filter paper. Compounds were screened for cardboard aroma by the trained sensory panel and then spiked into fresh WPC80 previously identified as free of cardboard flavor. Results from the real cardboard and brown paper reference samples indicated that aldehydes: pentanal, hexanal, heptanal, octanal, nonanal and decanal, were present at highest concentrations in cardboard samples which scored the highest sensory panel cardboard intensity and similarity to whey protein cardboard flavor. Analysis of volatile compounds from stored and fresh whey proteins with and without cardboard flavor also suggested aldehydes as the contributors to cardboard flavor. Sensory analysis of the aroma of the chemical standards yielded no single aldehyde as exhibiting a cardboard aroma, suggesting that cardboard flavor does not result from one compound, but a combination. Combinations of pentanal/heptanal, heptanal/hexanal, heptanal/nonanal, and pentanal/heptanal/nonanal were all characterized by fatty/cardboard aromas when added back to rehydrated whey protein solutions. These results suggest that lipid oxidation aldehydes are the source of cardboard off flavor in whey proteins.

Key Words: off flavors, whey protein, cardboard flavor

W86 Salty taste in dairy foods: Can we reduce the salt? S. L. Drake*, K. Lopetcharat, and M. A. Drake, *North Carolina State University*, *Raleigh*.

Sodium can be found in many sources of the diet. Dietary guidelines currently suggest a maximum intake of 2300 mg of sodium per day, while the average consumer intake is 9 g per day. The main health concern with high consumption of sodium is hypertension. The objectives of this study were to identify the salty taste intensity of sodium chloride in water and various dairy food matrices, and to identify the just-noticeable difference (JND) in concentration where consumers notice a decrease in salty taste in these foods. Solutions and foods (cheese sauce, cottage cheese and milk-based soup) were prepared with sodium chloride ranging in concentration from 0.008 M to 0.06 M. Fifteen panelists evaluated the salty intensity of each product in triplicate using a magnitude estimation scale (MES). In subsequent tests, panelists (n=25) evaluated salty intensity of these food products in separate sessions using an ascending force choice method to determine the JND. MES data was log-transformed, and all data was analyzed by analysis of variance with Fisher's least significant difference for means separation. The linear proportion of the power function in the salty taste intensity curve established for sodium chloride solutions and the three foods was between 0.03 M and 0.08 M. Consumers were able to notice and correctly identify a 25% reduction in salt concentration in all products. These results suggest that reducing sodium in cheese sauce, cottage cheese, and milk-based soups may be challenging and that exploration of sodium chloride alternatives in these foods is warranted.

Key Words: sodium reduction, salty taste, salt

W87 Binding affinity of various strains of lactic acid bacteria to phospholipids found in buttermilk. M. Cleveland* and R. Jiménez-Flores, *California Polytechnic State University*, *San Luis Obispo*.

Milk products are an important source of phospholipids (PL). PL are potentially excellent ingredients in food formulations due to the emulsifying power of their amphiphilic structure, and are particularly abundant in sweet buttermilk. Dairy foods are also an excellent medium for the survival and delivery of lactic acid bacteria (LAB), also known as probiotics. LAB have well-established roles in human health, especially in digestive and immune function, and have become a popular addition to many processed foods. If LAB are to benefit the host, however, it may be helpful if they are bound to a component in the food which enhances their survival during product shelf-life and during digestion. Previously in our lab, we observed specific binding of LAB to PL. We were recently interested in developing an assay to evaluate the binding affinity of various strains of LAB to the most abundant PL in buttermilk, including sphingomyelin (SM), phosphatidylcholine (PC), and phosphatidylethanolamine (PE). An immunoblotting technique was used to quantitatively measure this binding. Five PL standards were applied to both polyvinylidene fluoride (PVDF) and nitrocellulose membranes (NCM) and incubated with eight strains of biotinylated LAB, including Lactobacillus reuteri and Lactobacillus acidophilus. The interaction between them was measured using two methods of signal development. These included HRP-conjugated streptavidin with a diaminobenzidine color reaction, and fluorescent streptavidin with signal visualized under ultraviolet light. Binding affinity was assessed using densitometry. We found that L. reuteri had an especially strong affinity for most PL, and that SM was preferred by most LAB strains. From these results, we conclude that we have established a unique tool useful to researchers in determining which probiotic strains have optimal bioactivity in the desired application.

Key Words: phospholipids, lactic acid bacteria

W88 Non-casein nitrogen analysis of microfiltration and ultrafiltration retentate. H. Zhang*[1,2] and L. E. Metzger[1,2], [1]*Midwest Dairy Foods Research Center*, *Brookings, SD*, [2]*South Dakota State University*, *Brookings*.

Previous research has suggested that the standard non-casein nitrogen (NCN) method for milk overestimates the NCN content of ultrafiltration and microfiltration retentate samples. The objective of this study was to develop a modified method to more accurately measure the

NCN content of retentate products. In the standard method, a 10g milk sample (or equivalent protein content of retentate sample) and 75mL of 38 °C water are placed in a 100-mL volumetric flask. 1 mL 10% acetic acid solution is added and the flask is incubated at 38 °C for 10 min. Subsequently, 1mL of 1N sodium acetate solution is added and mixed. After cooling the content to 20 °C, the flask is made up to 100 mL, mixed, and then filtered (Whatman No1). The nitrogen content of the filtrate is then determined by Kjeldahl analysis. In preliminary research, a method was developed that used a 50mL centrifugal tube instead of the volumetric flask. This modification facilitated measurement of the pH after addition of acetic acid. Additionally, the sample was centrifuged (800 x g) for 10min to facilitate filtration with a smaller pore size filter paper (Whatman No 6). Subsequently, a study was completed to evaluate the impact of :1) pH after addition of 1% acetic addition solution and 2) pH of filtrate on NCN analysis. In this study, a microfiltration retentate sample (10% protein) was analyzed using four pH levels after acetic acid addition (4.0, 4.2, 4.4, and 4.6) and two pH levels after sodium acetate addition (4.6 and 4.8). Each pH combination was performed in triplicate. In this study we found that as the pH after acetic acid addition was increased from 4.0 to 4.6 the NCN content decreased. Additionally, the NCN content tended to decrease when the final pH of the filtrate was increased from 4.6 to 4.8. These results indicate that modifications in the standard method for NCN analysis may improve the accuracy of NCN analysis of retentate products.

Key Words: non-casein nitrogen, retentate, pH

W89 Effect of processing and refrigerated storage on isoflavone and stachyose contents of yogurt fortified with nongerminated or germinated whole soy powder. U. Nsofor* and Z. Ustunol, *Michigan State University*, *East Lansing*.

Fortification of yogurt with soy and soy ingredients has been of interest to combine health benefits of soy with dairy ingredients. Dairy yogurts fortified with germinated or nongerminated spray dried whole soy powders (50:50 blend) and cultured with *Streptococcus salivarius* subsp. *thermophilus*, *Lactobacillus delbreuckii* subsp. *bulgaricus* and a probiotic *Lactobacillus acidophilus* NCFM were manufactured using standard yogurt manufacturing procedures. The soybean varieties utilized for yogurt making were Vinton 81, DF 222 and E05276-T. All soy and all dairy yogurt controls were also included. All yogurts manufactured were evaluated for isoflavones (genistein, daidzein, genistin, daidzin) at one week of manufacturing and after six weeks of storage at 4°C using reverse-phase HPLC. Stachyose content was also determined. Total concentration of the four isoflavones evaluated increased ($p<0.05$), after 6 weeks of storage in all soy fortified dairy yogurts. The isoflavones retained in the soy and soy- fortified yogurts were significantly ($p < 0.05$) higher after 6 weeks of refrigerated storage compared to the isoflavone contents of the corresponding soy powders that was utilized in the yogurt base. There were differences in isoflavone concentrations between the yogurts due to the different soybean varieties used. All the yogurt samples containing germinated soy powders had lower stachyose contents than non-germinated soy-fortified yogurts. Germination of soybeans and subsequent fermentation by lactic acid bacteria during yogurt making was shown to enhance isoflavone content and reduce the stachyose contents soy fortified dairy yogurts.

Key Words: yogurt, soy, isoflavones

W90 The effect of pH and whey protein nitrogen (WPN) on the heat stability of medium heat nonfat dry milk powders. V. Sikand*[1], E. Ng[1], S. Gualco[1], A. Hui[1], P. S. Tong[1], and J. H. Walker[2], [1]*Dairy Products Technology Center, Cal Poly State University*, *San Luis Obispo*, [2]*Statistics Department, Cal Poly State University*, *San Luis Obispo*.

Heat stability (HS) of milk is the ability to withstand high temperature without coagulation. Almost every dairy product is heat-treated for food safety and specific functional properties. This study assesses how HS is related to pH and WPN in medium heat nonfat dry milk (NFDM) powders. The NFDM powders were reconstituted into an unconcentrated fluid milk (UFM) containing 9% total solids (TS) and a concentrated fluid milk (CFM) containing 18% TS. Samples were studied at their natural pH and at adjusted pH values from 6.5 to 6.8 for UFM and between 6.3 and 6.6 for CFM. The pH of the samples was adjusted by drop wise addition of either 1N NaOH or HCl. HS is defined as the heat coagulation time (HCT), which is the time between inserting the samples in a hot oil bath and the onset of visible clots. HCT was measured at 140°C for UFM and at 120°C for CFM. For UFM, the HCT of the natural and pH adjusted samples was positively related to WPN ($p < 0 .0001$) and quadratically related to adjusted pH ($p < 0.0001$). For unconcentrated milk, the HCT - pH curve maximum was found to be at 6.6. For CFM, the HCT of the natural and pH adjusted samples was also positively related to WPN ($p < 0.0001$) and quadratically related to adjusted pH ($p < 0.0001$). The HCT - pH curve maximum for concentrated milk was found to be at 6.5. In both concentrated and unconcentrated samples, the shape of the HCT - pH curve changes as WPN increases. In sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE) under non-reduced conditions, decreased band intensities for the β-lactoglobulin and α-lactalbumin were observed for less heat stable samples. These results complement the low WPN values obtained for less heat stable samples. The lower band intensities of β-lactoglobulin and α-lactalbumin suggest that a portion of these proteins could not enter the gel. This is likely due to differences in degree of protein aggregation that could have occurred during powder manufacture and/or storage. These results indicate that the HS of UFM and CFM depends upon pH and WPN. This information forms the basis for better selection of nonfat dry milk powder for optimum HS.

Key Words: heat stability, WPN, NFDM

W91 Dietary milk fat globule membrane (MFGM) reduces the incidence of aberrant crypt foci (ACF) in Fisher-344 rats. K. J. Hintze*[1], D. Snow[1], R. Jimenez-Flores[2], J. Campbell[1], and R. E. Ward[1], [1]*Department of Nutrition and Food Sciences, Utah State University*, *Logan*, [2]*Dairy Products Technology Center, Department of Agriculture, California Polytechnic State University*, *San Luis Obispo*.

The aim of this study was to determine if MFGM as a dietary fat source confers protection against chemically induced colon cancer compared to anhydrous milk fat (AMF) and corn oil (CO). Milk fat globular membrane (MFGM) is a complex mixture of membrane lipids (phospholipids, sphingolipids, plasmalogens, gangliosides) and glycoproteins which surround fat globules in milk. Butter production generates substantial amounts of MFGM by lysis and disaggregration of the fat globule. MFGM may be recovered from the buttermilk for use as a nutraceutical. Previous studies have shown that sphingomyelin and glycosphingolipids purified from milk inhibit chemically induced colon cancer in the rodent ACF model. ACF are pre-neoplastic lesions that can develop into tumors; the ACF model is well established and has been used extensively in nutritional studies to model colon cancer. Male, weanling Fisher-344 rats were randomly assigned to one of three

dietary treatments: 1) AIN 93 diet, CO as the fat source; 2) AIN 93 diet, AMF as the fat source and 3) AIN 93 diet, 50% MFGM, 50% AMF as the fat source. MFGM was isolated from buttermilk by ultrafiltration. Diets were balanced for micro and macro nutrients including casein and lactose. Diets differed only in fat source. Rats were fed experimental diets for 15 weeks and injected with the carcinogen 1,1-dimethylhydrazine at weeks 3 and 4. After sacrifice, colons were harvested and aberrant crypt foci were counted by microscopy. There were no significant effects of dietary treatment on feed consumption or weight gain. Rats fed the MFGM diet (n=15) had significantly less aberrant crypt foci (20.9 ± 5.7, mean ± std. dev.) compared to rats fed CO (n=16) or AMF (n=15) diets (31.3 ± 9.5 and 29.8 ± 11.4 respectively; $P < 0.05$). These results indicate that MFGM may be protective against colon cancer, possibly by providing dietary sphingolipids.

Key Words: milk fat globular membrane, anhydrous milk fat, colon cancer

W92 Codon optimization of bovine prochymosin gene and its expression in *Kluyveromyces lactis*. F. Zhen*[1] and Z. Lanwei[2], [1]*College of Food Science, Northeast Agricultural University, Harbin, Heilongjiang Province,China*, [2]*College of Food Science and Technology, Harbin Institute of Technology, Harbin, Heilongjiang Province,China*.

Chymosin as an important industrial enzyme has been widely used in cheese manufacture. To improve expression efficiency of recombinant bovine chymosin in *Kluyveromyces lactis* GG799, the DNA sequence encoding prochymosin was designed and synthesized based on the codon bias of *K. lactis*, the codons encoding 315 amino acids were optimized, in which a total of 333 nucleotides were changed. At shaking flask level, chymosin activity is 575U/mL. Compared to the nonoptimized control, expression level of the optimized chymosin based on preferred codons in *K. lactis* shown a 7-fold higher level. The purified enzyme had a molecular mass of 36.5 kDa on SDS-PAGE. Whole bovine casein was incubated with the recombinant chymosin or bovine chymosin and some breakdown products were analysised by SDS-PAGE, as does bovine chymosin.

Key Words: prochymosin, codon optimization, *Kluyveromyces lactis*

W93 Effect of carbon dioxide addition on refrigerated raw milk proteolysis. P. C. B. Vianna, M. T. Ruiz, and M. L. Gigante*, *State University of Campinas, Campinas, SP, Brazil*.

Proteolysis in raw milk can be caused by plasmin and by psychrotrophic bacteria enzymes. These bacteria are inhibited through dissolution of carbon dioxide (CO_2) in milk. The objective of this study was to evaluate the effect of CO_2 addition and the storage temperature on proteolysis of raw milk. Control (without CO_2 addition) and treated (added with CO_2 until pH 6.2) milk samples were placed in 300 ml glass bottles fitted with metal lids and stored at 4±1°C and 7±1°C. Proteolysis was evaluated every other day until the standard plate count (SPC) had reached 7.5×10^5 ufc/ml, which corresponds to the raw milk microbiological standard established by the Brazilian legislation. Split-split-plot design was used and the complete experiment was replicated two times. Decreased in casein as a percentage of true protein (CN/TP) was used as an index of proteolysis. The treatments effects on the proteolysis were evaluated by multivariate variance analysis. Raw milk presented typical whole milk composition and the standard plate count was 3.7×10^3 ufc/ml. After the addition of CO_2, its concentration in milk was 1190 ppm and remained constant during the whole analysis period. The shelf life for samples stored at 4°C, with and without CO_2 addition, was 14 and 12 days, respectively, while for samples stored at 7°C was 8 and 6 days, respectively. CO_2 addition and storage temperature did not affect the proteolysis but the storage time and the interaction CO_2 x storage time significantly affected it. CN/TP decreased during storage time for all samples, however, this decrease was faster for samples without CO_2 addition. Independent of temperature, milk with CO_2 addition had a CN/TP reduction of 1.6% at the end of its shelf life (SPC $\geq 7.5\times10^5$ ufc/ml), while samples without CO_2 addition showed a reduction of 5.0%. The CO_2 addition showed efficiency to delay the proteolysis in refrigerated raw milk probably because of the inhibition of psychrotrophic bacteria growth.

Key Words: carbon dioxide, psychrotrophic bacteria, proteolysis

W94 Expression of bovine trypsin in *Lactococcus lactis*. L. Yao[2], X. Han[2], X. Qu[2], B. Li[2], Y. Jiang[2], and Y. Jiang*[1,2], [1]*National Dairy Engineering & Technical Research Center, Northeast Agricultural University, Harbin, China*, [2]*Key Lab of Dairy Science, Ministry of Education, Northeast Agricultural University, Harbin, China*.

Bioactive peptides derived from milk have remarkable ability to lower blood pressure, regulate immue system, stimulate calcium absorption and so on. Protease of lactobacillus can produce bioactive peptides by hydrolyzing milk protein casein in fermented dairy products. To produce bioactive peptides more effectively, we should improve the hydrolysis ability of lactobacillus. The objective of this study is to construct a *Lactococcus lactis* (*L. lactis*) which can express bovine trypsin. The bovine trypsin gene was synthesized artificially based on its amino acid sequence and bias codon of *L. lactis*, with restriction sites *Nsi* I and *Spe* I at 5′ and 3′, respectively, for subsequent cloning in expression vector pSEC-E7. The gene was directly digested with *Nsi* I and *Spe* I enzymes and cloned into purified *Nsi* I - *Spe* I -cut pSEC-E7 vector , resulting in the pSEC: Trypsin plasmid. Then this recombinant plasmid was transformed into *L. lactis* strain NZ9000 carrying regulatory genes *nisR* and *nisK* to obtain the strain NZ(pSEC: Trypsin) by electroporation. The expression of trypsin gene induced by nisin was identified by RT-PCR, SDS-PAGE and Western blot. RT-PCR showed that the bovine trypsin was expressed at the RNA level. Analysis of induced cultures of *L. lactis* strain NZ(pSEC: Trypsin) revealed a band of ~ 27kDa in the cell fraction, whereas no signal was detected in the supernatant. As expected, Western blot analysis revealed a one major band of ~ 27kDa corresponding to SP_{Usp45}-Trypsin. The recombinant expression vector has been obtained and the expression of bovine trypsin has been detected in *L. lactis* strain NZ9000. *The work was supported by Hi-Tech Research and Development Program of of China (2008AA10Z311), the Science and Technology Program of Heilongjiang Province (GB07B406) and the Innovative Research Team Program of Northeast Agricultural University (CXT007-3-2).*

Key Words: bovine trypsin, *Lactococcus lactis*, expression

W95 Effect of the protein fractions of the milk serum, alpha-lactalbumin and beta-lactoglobulin, on the *Escherichia coli* O157:H7 colonization in the intestinal mucosa of mice. J. P. Teixeira[2], N. Silva[2], L. M. Fonseca*[1,3], and R. L. Bradley Jr.[4], [1]*Federal University of Minas Gerais (UFMG), School of Veterinary Medicine, Department of Food Technology and Inspection, Belo Horizonte, MG, Brazil*, [2]*Federal*

University of Minas Gerais (UFMG), School of Veterinary Medicine, Department of Preventive Veterinary Medicine, Belo Horizonte, MG, Brazil, [3]Laboratory of Milk Quality Analysis, UFMG, Belo Horizonte, MG, Brazil, [4]University of Wisconsin, Madison.

The effect of dietary whey protein concentrate on adhesion and colonization of enterohemorrhagic *Escherichia coli* O157:H7 in small intestine of Balb/C mice was evaluated. Eight groups containing six females each one were separated and randomly assigned to the following diets (two groups for each diet): standard diet (AIN93G; control group) and three groups with modified diet (AIN93 modified with addition of alpha-lactalbumin fraction; AIN93 modified with addition of beta-lactoglobulin fraction, and AIN93 modified with addition of whey protein concentrate - WPC). The protein fractions were obtained as described in US Patent n.6,900,290. Water was administered ad libitum during the experimental period of seven days. The experimental groups received aliquot of 0.5ml of *Escherichia coli* O157: H7 (ATCC 43895), in the concentration of 7 x 10^{10} CFU/mL using a gavage cannula. The animals had been examined clinically and sacrificed in the 8th experimental day, following recommendations of the bioethics committee (CETEA/UFMG). Samples of intestinal portions were submitted to histopathology and morphometry. The statistical analyses was done by the t-Student Test and by ANOVA including analysis of variance and test of multiple comparison according to Tukey (Software GraphPad Prism® 3.0.3 - San Diego). The diet containing fractions of beta-lactoglobulin and alpha-lactalbumin resulted in protective effect on the intestinal vilosity, respectively, of the distal part of the jejune and the ileum ($p \leq 0,05$) in Balb/C mice infected by *Escherichia coli* 0157:H7. On the other hand, the WPC did not demonstrate protective effect on the intestinal vilosity. Results showed that whey proteins present great potential for the control of intestinal infections caused by *Escherichia coli* 0157:H7.
Acknowledgements: FAPEMIG; CNPq; CAPES.

Key Words: whey protein, labctalbumin, *Escherichia coli*

Extension Education

W96 Effects of heat mount detectors, season, breed, and lactation on reproductive efficiency in summer and winter of dairy cows marked with chalk.
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To determine effects on reproduction, cows (n=410) housed in free stalls and milked in a rotary parlor were assigned on May 26 (S) or January 6 (W) to treatments as cows (C) marked with chalk as an aid to detect estrus or cows (MD) fitted with mount detectors plus marked with a 7-cm wide by 25-cm long chalk along the tail and backbone, beginning at the fifth coccygeal vertebra as the tail curves to form the backbone. Early in the trials, open cows at least 40 days post-partum with no prior breeding or declared open by palpation per rectum were synchronized for estrus and bred at 72 h after PG, unless bred earlier based on detection of estrus. Changes in status of detection aids and estrous activity were recorded at least 2× daily. Holsteins (H; n=134), Jerseys (J; n=189), crossbreds (X; n=38), and other breeds (O; n=49) were assigned 62% to C and 38% to MD. Status of cows following the 96-day spring/summer (S; n=152) and 86-day winter (W; n=258) trials was based on return to estrus and/or results of palpation of reproductive organs. Days from calving to assignment of treatment was not affected (P>0.10) by treatment (T) and lactation number (L) but was affected (P<0.01) by season (S), breed (B), and T×B. Treatment did not affect traits observed but T×L affected days between 1st and 2nd breeding (P<0.05) and days to pregnant (P<0.01). Days from start of trials to 1st breeding were affected (P<0.05) by TxB. Season affected days from start of trials to first detected breeding (P<0.05; S=33.2; W=27.1), days to 2nd breeding (P<0.01; S=61.6; W=48.3), and days to pregnant (P<0.01; S=49.9; W=35.6). Breed affected (P<0.05) days from calving to 1st breeding after treatment (H=113.8; J=102.6; X=90.9; O=98.8) and days from treatment to pregnant (H= 49.9; J= 38.7; X= 38.5; O= 43.8). Pregnancy rates were not affected (P>0.10) by T (C=54.7%; MD=52.6%). Overall, results indicated that heat mount detectors did not improve reproductive performance of dairy cows marked with chalk in the spring/summer and winter. Season, breed, and lactation number affected reproductive efficiency of the dairy cows.

Key Words: dairy, heat detection, estrus detection aid

W97 Improving IPM of house flies at commercial dairy operations through pest monitoring and determination of nuisance threshold.
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House fly abundance was monitored at three large dairy operations in Fresno County during the summer of 2005. Spot cards, fly tapes, and fly bait traps were simultaneously compared to detect early increases in house fly abundance while still providing manageable information during peak fly activity in mid-summer. Ten spot cards, five fly tapes, and five bait traps were placed to provide full coverage of each dairy. Spot cards and traps were replaced weekly. Fly counts varied significantly by trap location for all monitoring methods ($P < 0.006$). The correlation between fly counts at each trap location also varied considerably for all monitoring methods, with trap locations in near proximity or placed near similar habitats generally having significant correlations ($P < 0.05$). Spot cards and bait traps were similarly effective over a range of fly abundance. Spot card counts ranged from 35 to 5,940 spots per card across all dairies and weeks sampled, with mean spot card counts per dairy of 174 (±85), 461 (±221), and 1612 (±853) spots per card. Mean weekly spot card counts between dairies was significant ($P < 0.001$). Fly bait traps ranged from 41 to 4,545 house flies per trap across all dairies and weeks sampled. Mean bait trap counts per dairy were 600(±317), 1473 (±840), 2040 (±1275) with significant differences in mean weekly bait trap counts between dairies ($P < 0.001$). Fly tapes were ineffective due to tape failure (18% failure rate) caused by wind, dust, and heat. Spot cards required the least effort and cost to deploy while still providing acceptable resolution of changes in house fly abundance. An automated spot card counting system is needed to improve efficiency of this monitoring tool so that it might be adopted by the industry.

Key Words: fly control, IPM, pest monitoring