T90 Oxidation stability of milk rich in α-linolenic acid produced through duodenum infusion of high-linolenic perilla fatty acid into dairy cows. Q. S. Liu, J. Q. Wang*, D. P. Bu, E. Khas, G. Yang, L. Y. Zhou, P. Sun, and K. L. Liu, *State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences*, *Beijing, China*.

Our objective was to determine the effect of storage condition on oxidation stability of milk samples which were stored in dark under different storage conditions. The milk samples came from 4 primiparity Chinese Holstein cows infused with increasing amounts of high-linolenic perilla fatty acid into the duodenum (0, 100, 200, 300, 400 g/d), then stored in dark at either 4°C or 20°C for period of 0, 72, and 120 h. Data were analyzed statistically by using PROC MIXED of SAS. It was observed that at 0 h, the activity of total superoxide dismutase (T-SOD), total antioxidant capacity (T-AOC) in milk samples were tended to decrease linearly ($P = 0.21$, $P = 0.14$), but the content of thiobarbituric acid reactive substances (TBARS) was tended to increase linearly ($P = 0.18$) with the infusion increased, the oxidation stability of milk samples showed the tendency of decreasing at 0 h. Furthermore, the activity of T-SOD was not changed, the T-AOC decreased sharply $P = 0.0086$, the content of TBARS increased significantly ($P = 0.029$) with the infusion increased, the oxidation stability of milk decreased significantly when them stored at 4°C for 72 h, however, when stored for 120 h, the activity of T-SOD, T-AOC and the content of TBARS were not changed, which showed the oxidation stability of milk tended to remain stable at 4°C for 120 h. Milk samples stored at 20°C for 72 h, the activity of T-SOD, T-AOC tended to decrease ($P = 0.055$, $P = 0.07$). Content of TBARS tended to increase linearly ($P = 0.082$), which indicated that the oxidation stability of milk have the tendency of decreasing with the increasing amounts of α-linolenic acid, but for 120 h, the activity of T-SOD did not change significantly, the T-AOC tended to decrease quadratically ($P = 0.052$), the content of TBARS increased sharply ($P = 0.023$), therefore, the oxidation stability of the milk was decreased. Our results suggested that the oxidation stability of milk rich in α-linolenic acid produced through duodenum infusion perilla oil is decreased at the different storage conditions.

Key Words: milk samples, storage condition, oxidation stability

T91 Activity and viability of lactic acid bacteria in yogurts fortified with predigested non-germinated or germinated whole soy powder. U. Nsofor*[1,2] and Z. Ustunol[1], [1]*Michigan State University*, *E. Lansing,* [2]*Food and Drug Administration*, *College Park, MD.*

We have previously shown that pre-digestion and germination of soybeans hydrolyzes the non-bioavailable compounds into bioactive compounds and fermentation during yogurt manufacturing further increases their yield. The overall goal of this research was to determine the activity and viability of lactic acid bacteria in yogurt that has been fortified with predigested and non-germinated, or germinated soy powder, over the 6 week refregerated storage of the product. Swiss style reduced-fat strawberry flavored cow's milk yogurts fortified with germinated (GSP) or non-germinated (NGSP) spray dried whole soy powders (50:50 blend) and cultured with *Streptococcus salivarius* ssp. *thermophilus*, *Lactobacillus delbrueckii* ssp. *bulgaricus* and a probiotic *Lactobacillus acidophilus* NCFM were manufactured using standard yogurt manufacturing procedures. The soybean varieties utilized for yogurt making were Vinton 81 and DF 222. Treatments investigated were 50:50 blends of, GSP Vinton 81 + cow's milk, NGSP Vinton 81 + cow's milk, GSP DF 222 + cow's milk, NGSP DF 222 + cow's milk. All soy and all dairy yogurt controls were also included. Proximate analysis of all yogurt samples was conducted according to AOAC procedures. Activity and viability of the lactic acid bacteria was monitored at 7 d intervals over 6 weeks of refrigerated storage at 4°C. MRS, MRS-sorbitol and M17 agar were utilized to enumerate *Lactobacillus delbrueckii* ssp. *bulgaricus*, *Lactobacillus acidophilus* NCFM and *Streptococcus salivarius* ssp. *thermophilus*, respectively. The pH of each yogurt was determined at time of manufacture and also monitored at 7 d intervals for 6 weeks. The pH of the yogurts remained constant for up to 5 weeks of refrigerated storage. Cow's milk yogurt fortified with GSP DF 222 maintained highest ($P < 0.001$) activity and viability of lactic acid bacteria during the 6 weeks of the study, $>4 \times 10^7$ CFU/g. Activity and viability of the lactic acid bacteria was lowest in all soy yogurts during the same time frame, $<2.0 \times 10^6$CFU/g.

Key Words: yogurt, soy, lactic acid bacteria

T92 Sensory attributes of yogurt fortified with predigested, non-germinated or germinated whole soy powder. U. Nsofor*[1,2] and Z. Ustunol[1], [1]*Michigan State University*, *E. Lansing,* [2]*Food and Drug Administration*, *College Park, MD.*

Fortification of yogurt with soy and soy ingredients has been of interest to combine health benefits of soy with dairy ingredients. We have previously shown that pre-digestion and germination of soybeans hydrolyzes the non-bioavailable compounds into bioactive compounds and fermentation during yogurt manufacturing further increases their yield. The overall aim of this research was to determine the sensory attributes of cow's milk yogurt fortified with predigested and non-germinated, or germinated soy powder and compare these yogurts to their all soy and all dairy counterparts. Swiss style reduced-fat strawberry flavored cow's milk yogurts fortified with germinated (GSP) or non-germinated (NGSP) spray dried whole soy powders (50:50 blend) and cultured with *Streptococcus salivarius* ssp. *thermophilus*, *Lactobacillus delbrueckii* ssp. *bulgaricus* and a probiotic *Lactobacillus acidophilus* NCFM were manufactured using standard yogurt manufacturing procedures. The soybean varieties utilized for yogurt making were Vinton 81 and DF 222. Treatments investigated were 50:50 blends of, GSP Vinton 81 + cow's milk, NGSP Vinton 81 + cow's milk, GSP DF 222 + cow's milk, NGSP DF 222 + cow's milk. All soy and all dairy yogurt controls were also included. Proximate analysis of all yogurt samples was conducted according to AOAC procedures. A total of 112 untrained sensory panelists evaluated all 6 yogurt samples for appearance, body texture, flavor and overall acceptance on a 9-point hedonic scale. All yogurts had similar pH of 4.55 at the end of manufacturing. There were no significant differences in their compositional analysis. Sensory results showed there were no significant differences in appearance, body texture, flavor and overall acceptance between the cow's milk yogurt and the 50:50 blends containing germinated or non-germinated soy powder. There were also no noted differences in sensory attributes investigated between the 2 bean varieties (Vinton 81 and DF 222) studied. However, all soy yogurts were scored significantly lower ($P < 0.001$) than all other yogurts.

Key Words: yogurt, soy, sensory

T93 Effect of lactose content on the post-acidification of yogurt. V. Sikand*, P. S. Tong, and S. Roy, *California Polytechnic State University*, *San Luis Obispo*.

The manufacturing of yogurt involves fermentation of milk by *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus thermophilus*. Two important properties of yogurt are that it contains live cultures and lactic acid. Because of the high residual lactose content in yogurt, lactic acid can continue to be produced during its refrigerated storage by *Lactobacillus bulgaricus*. This phenomenon is called "post-acidification." Yogurt can become too acidic (sour) because of its continued acidification and negatively affect the properties of the yogurt. The objective of this research was to control post acidification by reducing the amount of lactose in milk used for preparing yogurt. Two non-fat yogurt mixes were formulated to contain 5% protein and varying degrees of lactose as follows: Control yogurt mix containing 7% lactose made by adding 5.66% w/w nonfat dry milk powder to fluid skim milk and experimental yogurt standardized to 2% lactose by adding milk protein isolate (MPI) containing 87% protein to UF permeate obtained from skim milk. The UF permeate was used because of its similar mineral composition to milk. These mixes were stirred for 5 h and kept overnight in a refrigerator for complete hydration. On the next day, these yogurt mixes were heated at 85°C for 30 min, cooled to 42°C, mixed with commercial frozen yogurt culture (DVS YC-X11), and incubated until it reached pH 4.6. Basic composition analyses of these yogurt mixes showed similar mean protein values. The control yogurt mix had 0.18% fat content, 7% lactose, and about 13% total solids, while the experimental yogurt mix had 0.31% fat, 1.9% lactose, and 7.9% total solids. Relative to the experimental yogurt mixes, the control yogurt mixes showed a significant decrease in pH level from 4.53 to 4.24 ($P < 0.001$) and an increase in the titratable acidity (TA) from 0.98 to 1.21 ($P < 0.001$) over a 21-d refrigerated storage. However, for the experimental yogurt mixes, the decrease in pH and increase in TA was not significant ($P > 0.001$). Our results showed that limiting lactose content in the UF permeate used for yogurt mix help in controlling post-acidification of lactic acid development.

Key Words: yogurt, post-acidification, lactose

T94 Effect of a satiety ingredient on the properties of resulting yogurts during storage. D. Olson*[1], K. Aryana[1,2], D. Alexander[3], and T. Emmick[3], [1]*Louisiana State University Agricultural Center*, *Baton Rouge,* [2]*Louisiana State University*, *Baton Rouge,* [3]*Kemin Health*, *Des Moines, IA*.

Slendesta is an ingredient used for weight management by inducing satiety. The effect of the Slendesta level (0 (control), 150, and 300 mg/227 g yogurt) on the characteristics of the resulting vanilla yogurts during 0, 1, 3, 5, and 7 wk of 4°C storage was investigated. The resulting vanilla yogurts were analyzed for color (L*, a*, and b* values), pH, extent of syneresis, viscosity, log *Lactobacillus bulgaricus* and *Streptococcus thermophilus* counts, and sensory properties (flavor, body/texture, and appearance/color scores). The Slendesta level was significant for L* value, pH, extent of syneresis, viscosity, log *Lactobacillus bulgaricus* count, and appearance/color score. Increasing Slendesta level decreased L* value, pH, and extent of syneresis but tended to increase viscosity and log *Lactobacillus bulgaricus* count. The 150 mg Slendesta level yogurt had significantly higher appearance/color scores than the control. Age had a highly significant effect on L* value, a* value, pH, extent of syneresis, viscosity, log *Streptococcus thermophilus* count, and log *Lactobacillus bulgaricus* count and a significant effect on both the body/texture score and the appearance/color score. The highest L* value and a* value occurred at wk 0 and 1, and the pH decreased after wk 0. Both the extent of syneresis and the viscosity had a general tendency to increase with storage time. Although both log *Streptococcus thermophilus* counts and log *Lactobacillus bulgaricus* counts decreased with storage, the relative decrease in counts was more rapid for the log *Lactobacillus bulgaricus* counts. Body/texture scores were significantly higher at 3 wk than at 0 wk, while appearance/color scores were significantly higher at 0 wk than at 3 wk. Slendesta positively influenced some characteristics of yogurt.

Key Words: satiety, weight management, yogurt

T95 Chemical and sensory characteristics of set-type yogurts made from sheep, goat, and their mixed milks during refrigerated storage. A. C. Gürsoy-Balci[1], Z. Güler[1], and Y. W. Park*[2], [1]*Mustafa Kemal University*, *Antakya, Hatay, Turkey*, [2]*Fort Valley State University*, *Fort Valley, GA*.

In the countries of the Mediterranean basin, sheep and goat milk and their products have formed a vital part of its economy and cultural heritage. Sheep and goat milk products can provide a profitable alternative to cow milk products owing to their specific taste, texture, typicality and healthy image. Six types of yogurts were manufactured from pure goat milk of Damascus breed, pure sheep milk of Awassi breed, and mixed milk (50% each) of the 2 species using CH-1 and YF-3331 yogurt starter cultures to study chemical composition and sensory properties of the products in relation to free fatty acids (FFA) and volatile compounds (VC) profiles. Upon manufacture, the yogurts were stored at 4oC for 1, 7, 14 and 21 d before conducting chemical and sensory analyses. FFA and VC were determined on a capillary gas chromatography using aluminum adsorption and static headspace techniques. Results showed that cultures significantly affected acetaldehyde ($P < 0.05$), acetone ($P < 0.05$) and diacetyl ($P < 0.01$) contents, responsible for characteristic yogurt flavor, whereas type of milk had no effects. Type of milk influenced ethanol level, which was highest in goat yogurt. Significant variations occurred in acetaldehyde and diacetyl contents during the storage. FFA of hexadecanoic, octadecanoic and decanoic acids were significantly ($P < 0.05$) affected by type of milk. Type of culture influenced ($P < 0.05$) levels of C2 to C15 FFA, while type of milk affected C2 to C14 FFA contents. The mixed milk yogurt contained mean concentrations of 3.96 µg/g diacetyl, 6.69 µg/g acetoin, 41.43 µg/g acetaldehyde, 2.83 µg/g ethanol, 1.77 µg/g ethanoic acid, 1.33 µg/g hexanoic acid, 2.51µg/g decanoic acid, and 1.08 µg/g octanoic acid, respectively. It was concluded that yogurts made from the mixed milk had the highest sensory scores in taste and smell traits.

Key Words: sheep and goat milk, yogurts, chemical characteristics

T96 Oxidative stability of yogurt from bovine and caprine milks enriched with different levels of n-3 fatty acids. D. Dlders*, A. Mora-Gutierrez, R. Attaie, and G. L. Goodie, *Prairie View A&M University, Prairie View, TX.*

Incorporation of n-3 fatty acids into daily diet results in beneficial effects on vision, neural development, and lowers incidents of diseases such as coronary heart disease. The intake of n-3 fatty acids is generally low in the typical Western diet. Dietary intake of yogurt supplemented with physiologically significant amounts of n-3 fatty acid would contribute to a healthy life. However, the incorporation of n-3 fatty acids in foods would have to be limited due to their oxidative instability. The objective of this study was to evaluate the oxidative stability of yogurt from bovine and caprine milks enriched with different level of Menhaden oil containing 38% n-3 fatty acids. Non-fat yogurt from bovine and caprine milks were supplemented with 0.1, 0.2, and 0.4% Menhaden oil followed by homogenization. Yogurt samples were stored in the dark for 30 d at 4°C, and oxidative deterioration of samples were assessed at different intervals using thiobarbituric acid (TBA) test. As the level

of n-3 fatty acids increased in samples the TBA value also increased, regardless of storage time. Significant chelating activity ($P < 0.05$) was detected in yogurt samples containing iron as a chelating agent at 100 ppm. Furthermore, the yogurt made from caprine milk exhibited stronger chelating activity than the yogurt from bovine milk ($P < 0.05$). The high content of β-casein in yogurt from caprine milk is suggested to be involved in protection of n-3 fatty acids against lipid oxidation induced by iron. Yogurt in general seems to be a suitable vehicle for n-3 fatty acid fortification, particularly yogurt made from caprine milk.

Key Words: yogurt, oxidative stability, omega fatty acids

T97 Evaluation of non-essential and heavy minerals in three species milks, Torba yogurts, and whey. H. Sanal[1], Z. Guler[1], and Y. W. Park*[2], [1]*Mustafa Kemal University*, *Antakya, Hatay, Turkey*, [2]*Fort Valley State University*, *Fort Valley, Georgia, USA*.

Among concentrated yogurts, Torba yogurt is made by straining in a special cloth bag, which is the most commonly consumed in Turkey. Mineral contents of milk and dairy products are influenced by many factors such as animal species, feeds, environment, milking and manufacturing processes. This study was to determine non-essential and heavy metal concentrations in cow (Holstein), ewe (Awassi) and goat (Damascus) milks and their regular yogurts, Torba yogurt and whey. A Varian Vista-MPX simultaneous inductively coupled plasma optical emission spectrometer (ICP-OES) was used to quantify silver, aluminum, arsenic, boron, beryllium, cadmium, nickel, lead, antimony, titanium, thallium and vanadium in ashed milks and their respective products. Barium was not detected in goat and cow milk and their products. Among all elements, boron was most abundant, and highest in the cow milk. Species differences were observed between levels of certain health-related elements such as As, B, Ba, Cd, Ni, Sb and Ti in milk and their products. Mean lead contents of all 3 species milks were 3.0 ppm. Average contents (ppm) of Ag, Al, As, B, Ba, Be, Cd, Ni, Pb, Sb, Ti, Tl and V in cow milk and its Torba yogurt were: 0.27, 0.32; 5.31, 6.73; 1.91, 3.29; 24.0, 23.3; 0.0, 0.0; 0.04, 0.06; 0.21, 0.18; 2.47, 2.72; 3.05, 3.22; 1.27, 2.32; 0.31, 0.47; 7.01, 7.18; 0.72, 1.30, respectively. Milk, regular yogurt and Torba yogurt revealed good sources of non-essential elements, especially boron, lead, thallium and vanadium. The daily intake of these elements from these milks and yogurts appeared to exceed the provisional tolerable daily intake. Daily intake of toxic elements from milks and yogurts ranged between 2.16% (Be) and 116% (Pb). A long-term exposure of these elements from foods and environment has to be continuously monitored to maintain at their minimum levels for food safety.

Key Words: cow-sheep-goat milk, Torba yogurt, non-essential elements

T98 Impact of acidulant addition on yogurt fermentation times and physiochemical properties. T. A. Boomgaarden* and K. A. Schmidt, *Kansas State University*, *Manhattan*.

Consumers desire products that minimize their environmental impact; therefore, in recent years, a greater emphasis has been made for sustainable production of agricultural products. This research aimed at developing a yogurt process with reduced fermentation time, thus reducing energy needs and creating a more sustainable manufacturing process. Yogurt was manufactured by pre-acidifying nonfat yogurt mix (13.5% solids) with citric acid, lactic acid or concentrated lemon juice (CA, LA, LJ) at 200 ppm before or after heat treatment to pH 6.2, followed by fermentation at 42°C in a BioFlo 3000 (New Brunswick Scientific Co., Inc.) to a target pH of 4.6. Yogurts were analyzed for *L. bulgaricus* and *S. thermophilus* counts at the beginning and end of fermentation. Three randomized replications were completed and all tests were done in duplicate and averages were reported. Results showed that CA or LJ added after heat treatment reduced fermentation time by 13% compared with the control; whereas, CA and LJ added before heat treatment had no effect. LA added before or after heat treatment increased fermentation time by 16%. Counts of *L. bulgaricus* and *S. thermophilus* were similar, with initial counts of 6.9 and 7.7 log CFU/mL respectively, and end counts of 7.1 and 7.7 log CFU/mL respectively. In addition, control yogurt and yogurts with CA and LJ added after heat treatment were manufactured and fermented in 90 mL sterile cups and assessed for pH, texture and rheological (G', G") characteristics at d 1. Statistically, the CA and LJ yogurts had less firmness (202 g and 212 g) and greater pH (4.58 and 4.57) compared with the control yogurt (231 g and 4.53). Control yogurt had greater G' and G" values at a frequency of 1 Hz than CA and LJ yogurts. These results show that partial acidification of the yogurt mix with CA or LJ after heat treatment reduced fermentation time but some physiochemical parameters, particularly texture, were affected. This new yogurt has potential for success in the marketplace because it appeals to consumers seeking sustainable products and could be easily implemented by manufacturers.

Key Words: yogurt, fermentation time, sustainable manufacturing

T99 Antioxidative peptides isolated from fermented whey proteins by lactobacilli and their effects on aged mice. Y. Bao*[1], X. Liang[1], L. Qin[1], R. Li[1], and M. Guo[2], [1]*Northeast Forestry University*, *Harbin, China*, [2]*University of Vermont*, *Burlington*.

Natural proteins can be partially hydrolyzed to produce peptides that may have biological functions. The objectives of the study were to prepare functional peptides from fermented whey protein concentrate (WPC) by *Lactobacillus plantarum A9* and *Streptococcus thermophilus* S33, and to characterize their antioxidative properties. The optimum conditions for producing antioxidative peptides were: inoculate rate 5%, culture ratio 1:1, fermentation temperature at 37°C and pH at 6.4, and fermentation time for 16 h. Two fractions were obtained using ultrafiltration and their relative molecular weights were 328 and 2,031, respectively. The induced model aged mice were treated by neck back subcutaneous injection of D-galactose every day for 45 d. The mice were given 3 different doses of whey protein peptides (WPP) at 100, 200 and 400 mg/kg body weight per day, respectively. The effects of WPP on the levels of catalase (CAT), malondialdehyde (MDA), superoxide dismutase (SOD), glutathione peroxidase (GSH-PX) in serum, liver and brain were evaluated after 45 d. The CAT, SOD and GSH-PX activities in the induced aged group decreased while MDA increased compared with control mice. However, the activities of CAT, SOD, and GSH-PX in the organs of induced aged mice fed with the WPP were significantly increased especially for the higher dose group ($P < 0.05$). The results showed that antioxidative peptides could be prepared from fermented WPC using *Lactobacillus plantarum A9* and *Streptococcus thermophilus S33* for functional foods applications.

Key Words: peptides, whey protein, fermentation

T100 Zinc-binding activity of yak casein hydrolysate and the structural characteristics of hydrolysate-Zn complex. X. Y. Mao*[1], X. Wang[1], J. Zhou[1], and P. S. Tong[2], [1]*College of Food Science & Nutritional Engineering, Key Laboratory of Functional Dairy of Chinese Ministry of Education, China Agricultural University*, *Beijing, China*, [2]*California Polytechnic State University*, *San Luis Obispo*.

The bioavailability of zinc is very important for its absorption. Many factors can affect the bioavailability of dietary zinc in dairy food systems. Some proteins or peptides can form complex with zinc, which makes zinc soluble and increases its absorption and bioavailability in intestinal basic conditions. The aim of this work was to: 1) determine the Zn-binding activity of yak casein hydrolysate and 2) verify that casein hydrolysate can really form complex which is soluble in a simulated intestinal environment. The capacity of yak casein hydrolysate to form complexes with zinc was quantified. Zinc chelation by casein hydrolysate was described by means of UV-visible spectrophotometry (UV-vis) and Fourier transform infrared spectroscopy (FTIR). Results showed that casein hydrolysate prepared with Alcalase and trypsin possessed the highest Zn-binding activity compared with casein hydrolysates prepared with pepsin, Flavozyme or papain ($P < 0.05$). The 6h-hydrolysate obtained with Alcalase, which is an endopeptidase from *Bacillus licheniformis*, showed the highest Zn-binding activity and significantly higher than that of the native proteins. The UV-vis absorption spectra showed that absorbance spectra changed between yak casein hydrolysate and its zinc complex in the area of 230–300 nm. The absorbance of casein hydrolysate-Zn complex at 270–300 nm was significantly lower than that of casein hydrolysate itself at the same wavelength. The oxygen atom of the carbonyl group in peptides could chelate with Zn^{2+} and lead to the hypochromic shift of its typical bands. Furthermore, FTIR spectra showed that the absorption at wave numbers between 1 450 cm^{-1} and 1 000 cm^{-1} increased when yak casein hydrolysate and Zn^{2+} formed complexes. Casein hydrolysate-Zn complex exhibited strong bands at the wave numbers of 1449 cm^{-1} and 1406 cm^{-1} that are the characteristic stretching mode of C = N. The FTIR spectra verify that some sites of yak casein hydrolysate can bind with zinc, and the formed substance is a Zn-binding complex which may be useful and practical in the prevention and treatment of Zn deficiency.

Key Words: yak casein hydrolysate, Zn-binding capacity, characterization

T101 Functional and volatile properties of milk serum protein concentrates. L. E. Coppola*[1], S. A. Rankin[1], M. S. Molitor[2], and J. A. Lucey[1], [1]*University of Wisconsin-Madison*, [2]*Wisconsin Center for Dairy Research*, *Madison*.

Microfiltration, commonly used in the dairy industry for removal of fat and bacteria from milk, can also be an effective tool to isolate milk serum proteins for the production of milk serum protein concentrate (MSPC). MSPC has less fat, undergoes fewer heat treatments, and is free of rennet and other by-products of the cheese-making process, likely causing it to have improved functionality over traditional cheese whey protein concentrate (WPC). Because solubility, turbidity, foaming, and volatile composition are vital characteristics for many food applications, this study compared these features of MSPC and WPC. Milk permeate was produced from pasteurized, unhomogenized skim milk at temperatures of ~5°C and ~23°C using polymeric, cross-flow microfiltration. Permeates were concentrated by ultrafiltration and spray dried to obtain MSPC powders of ~80% protein. The MSPC powders were compared with a traditional WPC80 from Swiss cheese whey made at Babcock Dairy Plant and 3 commercial WPC. SDS-PAGE results showed that protein composition was significantly different with the MSPC made at 5°C containing more β-casein than the other MSPC or WPC samples (~15% vs. <5%). Both MSPC were significantly ($\alpha = 0.05$) different in standard foaming, turbidity, and solubility tests than WPC samples. MSPC generated larger foam overruns (>2000% vs. <800%) and more stable foams (>14 min vs. <5 min), solutions were less turbid (>90% vs. <25% transmission), and powder had higher solubility compared with WPC samples (over pH range 3–7). Furthermore, MSPC made at 5°C had significantly larger foam overrun (>30000%) and greater foam stability (>2 h) than MSPC made at 23°C (<1200% overrun, stability <15 min). Analysis of volatile content of the powders by SPME-GC/MS showed that the number of different types of volatile compounds present in both MSPC was significantly lower than the number present in WPC samples. In addition, accelerated storage of MSPC at 50°C for 28 d resulted in fewer types of volatiles increasing in intensity during storage compared with WPC samples where many volatiles increased in intensity during storage. MSPC has distinctive flavor and performance attributes that may result in enhanced functionality in specific types of food applications.

Key Words: milk serum protein, protein concentrate, whey

T102 Volatile profiles of commercial starter distillates and diacetyl levels in selected dairy food. M. I. Rincon*, A. Lopez-Hernandez, M. S. Surianto, A. R. Rankin, and S. A. Rankin, *University of Wisconsin-Madison*, *Madison*.

Starter distillates are used as ingredients in the formulation of many dairy products such as cottage cheese, margarine, spreads, processed cheese, and sour cream to increase the levels of naturally occurring aroma compounds associated with lactic acid bacteria (LAB) fermentation. Diacetyl is a highly volatile product of the citrate metabolism of certain LAB including *Lactococcus lactis* ssp. *diacetylactis* and *Leuconostoc citrovorum* that imparts a high level of "buttery" flavor notes. In the US, starter distillates are regarded as generally recognized as safe and usage in food products is only limited by good manufacturing practices. Little is known but the volatile composition of starter distillates and the level of diacetyl in finished products. The objective of this work was to characterize the volatile constituents of 11 commercial starter distillates and to quantitate the levels of diacetyl in several commercial dairy products where starter distillates are used as flavorants. The headspace volatiles were assessed using a solid phase microextraction fiber and analyzed by GC-MS. The identity of the aroma compounds present in the samples was confirmed by matching the corresponding mass spectra with those in a NIST database and by comparing the retention times to those of authentic standards. The levels of diacetyl in the 11 commercial starter distillates ranged from 5,000 to 30,000 ppm. In addition to diacetyl, significant levels of acetoin, acetic acid, acetaldehyde, furfural, benzaldehyde, fatty acids, ethyl acetate were found. A total of 10 samples of cottage cheeses, margarines, spreads, and butter sprays were found to contain diacetyl in the range of 10 to 100 ppm. The results obtained in this work summarize the volatile composition of commercial starter distillates and the approximate levels of diacetyl in selected foods.

Key Words: diacetyl, starter distillates, volatiles in dairy products

T103 Sensory properties of chocolate flavored, protein fortified, fluid milk based recovery beverages produced using indirect and direct thermal processing. A. Lammert*[1], A. Olabi[2], K. Brooks[1], S. Vink[1], and P. Tong[1], [1]*California Polytechnic State University*, *San Luis Obispo,* [2]*American University of Beirut*, *Beirut, Lebanon*.

Protein′s role in post exercise muscle recovery is well documented and numerous beverages are commercially available. However, fluid milk is typically not the first ingredient. The objective was to determine differences between sensory properties of a chocolate flavored, protein fortified fluid milk based recovery beverage that contained 25 g of protein per 12 ounce serving using indirect and direct thermal processing methods. Beverages were formulated using milk, whey protein concentrate (WPC), fructose, sucrose, carrageenan, salts, flavors and

cocoa. WPC was mixed and hydrated for 30 minutes in the milk. The remaining dry ingredients were blended and added to the hydrated WPC/milk mixture and mixed for an additional 5 minutes. The mixture was UHT processed at 285°F for 3 seconds using indirect or direct heat and bottled in a clean fill hood. Descriptive sensory analysis using a trained panel was completed on two week old beverages and the characteristics evaluated were appearance, odor, flavor, texture, and aftertaste. Results were analyzed using repeated measures ANOVA. WPC brand had a significant effect ($P < 0.05$) on mostly the appearance attributes in addition to sweet odor, chalkiness, viscosity and astringent and chalky aftertastes. There was no effect ($P > 0.05$) on most odor and flavor attributes. Processing method had a significant effect on two appearance attributes and burnt odor, cooked flavor, chalky texture, and aftertaste. There was a significant WPC brand and processing method interaction ($P < 0.05$) for most appearance, texture and aftertaste attributes. Given the lack of major effects on odor and flavor attributes, our work indicated that chocolate protein fortified fluid milk based recovery beverages can be developed using different WPCs with minimal impact on sensory properties.

Key Words: fluid milk, descriptive analysis, whey

T104 Physicochemical properties of pomegranate flavored carbonated symbiotic beverage. H. Walsh*, J. Cheng, and M. Guo, *University of Vermont*, *Burlington*.

Drinkable yogurt is becoming popular in the US and other countries and is considered a functional food. Carbonation of drinkable yogurt may create a niche in the functional foods market. The objectives of this study were to develop a manufacturing technology for drinkable carbonated symbiotic yogurts, and to evaluate their physicochemical properties. Two flavors of yogurt drink: pomegranate (P) and vanilla (V) were formulated, each containing inulin as prebiotic and probiotic bacteria to produce symbiotic dairy beverages. The products were successfully stabilized with high methoxyl pectin and whey protein concentrate. The carbonation process was achieved using a pressurized carbonator for these yogurt drinks with approximately 3 volumes of food-grade carbon dioxide. The samples were sealed in glass containers to maintain carbonation levels. Three trials of each product were carried out and 3 replicates from each trial were taken for analysis. Protein fat, total solids and ash were determined using standard dairy analysis methods. Carbohydrate was determined by difference. Viscosity and pH were also analyzed using standard methods. Bottled samples were held at refrigerated temperatures (4°C) for 8 weeks to evaluate the stability of the product over time. Chemical composition of the carbonated beverages were as follows: Protein: 1.58 ± 0.05% (P), 1.59 ± 0.06% (V), Fat: 1.24 ± 0.2% (P), 1.18 ± 0.11% (V), Total Solids: 14.78 ± 0.11% (P), 14.93 ± 0.05% (V), Ash: 0.49 ± 0.02% (P), 0.46 ± 0.03% (V), Carbohydrate: 11.47 ± 0.12% (P), 11.69 ± 0.14% (V). The pH values of the beverage were 4.25 ± 0.04 and 4.22 ± 0.04 and viscosity values were 23.1 ± 3.2 and 25.8 ± 6.5 mPas, for pomegranate and vanilla samples, respectively. Intrinsic stability of the prototypes was maintained for at least 8 weeks. The new manufacturing technology for these prototypes may have potential for commercialization of symbiotic carbonated milk-based beverages.

Key Words: symbiotic, carbonation, beverage

T105 Development of symbiotic milk candy. J. McCarthy*, Z. Zhang, and M. Guo, *University of Vermont*, *Burlington*.

Milk candies made from dried milk are a popular item in Asian countries, but are uncommon in the United States. The objectives of this study were to develop a technology for making powdered milk based candy and analyze its chemical composition. With fortifications of probiotic bacteria as well as the prebiotic compound inulin, a new symbiotic milk candy was developed. A base powder mix was formulated using a combination of skim milk powder, whole milk powder, sugar, maltodextrin and inulin, along with antioxidants and probiotics (*L. acidophilus, L. rhamnosus, L. casei,* and *Bifidobacterium* ssp.) followed by thorough mixing. The mix was then pressed into hexagon tablets using the Colton 204 Rotary Tablet Press. Three trials of the prototype were prepared, and triplicates of each of the trials were analyzed for chemical composition using AOAC standard methods for content of protein, fat, total solids and ash. Carbohydrate content was determined by difference. Results were as follows: protein: 17.87 ± 0.19%; fat: 2.44 ± 0.07%; total solids: 96.93 ± 0.24%; moisture: 3.07 ± 0.24%; ash: 3.31 ± 0.47%; carbohydrates: 73.31 ± 0.37%. Each tablet weighed approximately 2 g and contained 150 mg of inulin and at least 10^9 probiotic cells. Results showed that this product is low in fat content and rich in high quality protein and may be a good vehicle for delivery of both prebiotics and probiotics.

Key Words: milk candy, symbiotic, milk powder

T106 Physicochemical properties of whey protein-based safe paper glue. J. Wang, J. Cheng*, and M. Guo, *University of Vermont*, *Burlington*.

Commercial paper glue products on the market may contain toxic organic compounds harmful to people and bad for the environment. To develop safe paper glues, whey protein-based glue prototypes were formulated using polymerized whey proteins (PWP) and other ingredients. Bonding strength, one of main indexes for glue products, was evaluated, along with the physicochemical properties of the prototypes compared with a commercial control sample. Reconstituted whey protein isolate (WPI) solution (10%, pH 7.0) was polymerized at 75°C for 15 min. The polymerized whey protein (PWP) was combined with PVA, (20%, w/w), emulsifier (propylene glycol) and antibacterial agent (1,2-benzisothiazolin-3-one). The best ratio of PWP solution to PVA solution was about 1.7 to 1.0 with 0.5% propylene glycol and 0.2% 1,2-benzisothiazolin-3-one. The experimental and control glues were sealed in plastic containers and held in an environment controlled chamber (23°C, 50% RH) for 6 mo to determine the bonding strength and physical properties and to evaluate the shelf life. Three trials of the glue prototype were carried out and 3 replicates from each trial were taken for chemical analysis. The bonding strength of the glue was evaluated according to a modified ASTM procedure (D1002–05) using an Instron Universal Testing Machine. Physicochemical properties, including viscosity as well as total solids, ash and protein content, were analyzed using AOAC standard methods. The bonding strength of the glue was 221.5 ± 5.06 N. Viscosity was 675.6 ± 34.6 mPa.s; total solids was 14.38 ± 0.04; ash was 0.27 ± 0.02%; and protein was 9.15 ± 0.07%. The bonding strength and viscosity of both whey protein-based safe paper glue and the control sample remained steady during 6-mo storage.

Key Words: paper glue, whey protein, physicochemical property