

## Dairy Foods: Dairy products

**T107 Angiotensin-converting enzyme inhibitory activity of whey proteins obtained from the manufacture of traditional Mexican cheeses.** Yuridia S. Tarango-Hernandez, Alma D. Alarcon-Rojo, Nestor Gutierrez-Mendez, and Jose C. Rodriguez-Figueroa\*, *Universidad Autonoma de Chihuahua, Chihuahua, Mexico.*

Traditional Mexican cheese production has been increasing in recent years. Thus, the increase in cheese whey volume must be carefully dealt with. Because of its high BOD ( $27\text{--}60\text{ g L}^{-1}$ ) and DOQ ( $50\text{--}102\text{ g L}^{-1}$ ), cheese whey represents a potential pollutant to the environment. However, studies have demonstrated the bioactivity of whey proteins. Therefore, this research aimed to evaluate the angiotensin-I-converting enzyme (ACE)-inhibitory activity of Fresco, Asadero and Chihuahua cheese whey. Samples corresponded to 3 different traditional cheese-making times. The  $<1$  and  $3\text{--}1$  kDa whey fractions were obtained by ultrafiltration. The ACE-inhibitory activity was evaluated by standardized RP-HPLC methodology. Results showed that all cheese whey fractions were able to inhibit ACE activity. The highest ACE-inhibitory activity ( $67.3 \pm 2.0\%$ ) was found in the  $<1$  kDa Fresco cheese whey fraction, however it was not significant different ( $P > 0.01$ ) from the Asadero cheese whey fraction ( $65.3 \pm 3.6\%$ ). In contrast, the  $<1$  kDa Chihuahua cheese whey fraction presented the lowest ( $P < 0.01$ ) activity ( $29.3 \pm 7.5\%$ ). The  $3\text{--}1$  kDa Asadero cheese whey fraction showed high ( $P < 0.01$ ) ACE-inhibitory activity value ( $66.1 \pm 3.6\%$ ). In conclusion, Asadero and Fresco cheese whey presented relevant ACE-inhibitory activity. Therefore, whey obtained from the manufacture of these traditional Mexican cheeses may have a potential to be used as functional ingredients.

**Key Words:** ACE-inhibitory activity, traditional Mexican cheese, whey

**T108 The effect of partially hydrolyzed different milk species on xanthine oxidase activity of fetal enterocyte culture.** Hristina Kocic\*, *Medical Faculty University Maribor, Maribor, Slovenia.*

Introduction of enteral nutrition in early life may lead to autoimmune, inflammatory and allergic reactions. Oxidative damage is a contributing factor in inflammatory bowel disease, necrotizing enterocolitis and ulcerative colitis. Xanthine oxidase (XO) plays an important role in oxidative injuries, because of the generation of free radical hydrogen peroxide ( $\text{H}_2\text{O}_2$ ). It can induce oxidative modification and may activate redox-sensitive transcription factors (NF- $\kappa$ B) and proinflammatory cytokines. This study was conducted with the aim to compare the effect of hydrolyzed milk samples,  $\beta$ -casein (CS) and  $\beta$ -casomorphin-7 (CSM-7) on XO activity in culture of fetal human enterocytes (commercial H4 cells). During exposure of H4 cells to hydrolysed milk species, XO activity (U/g prot) decreased significantly treated with hydrolyzates of human colostrum ( $85.28 \pm 7.31^*$ ), mature human milk ( $80.34 \pm 5.40^*$ ), donkey colostrum ( $91.82 \pm 4.47^*$ ), mature donkey milk ( $71.73 \pm 3.89^*$ ) vs  $165.33 \pm 3.40$  of control H4 cells. The activity did not change significantly by using cow colostrum ( $182.20 \pm 5.88$ ), but decreased with mature cow milk ( $101.84 \pm 11.56^*$ ). Significant decrease was observed for Bebelac formula 0 ( $96.35 \pm 8.89^*$ ), but not of Bebelac formula for 12 mo ( $139.36 \pm 5.88$ ). Both, CS and CSM-7 decreased XO activity ( $66.80 \pm 6.48^*$  and  $67.98 \pm 5.32^*$ ). Observed activities correlated positively with NF- $\kappa$ B activity, but negatively with proliferative (mitotic activity) of H4 cells. Exclusive breast-feeding has been associated with a reduction in the incidence of chronic inflammatory conditions, including autoimmune

diseases, allergies, asthma, atopic dermatitis and inflammatory bowel diseases, what may correlate with decreased oxidative stress. The use of donkey milk seems to be a promising strategy against allergic and other immune-related reactions, regarding oxidative injury and XO activity. Well-documented antioxidative properties of CS may be due to decreased XO activity. Well-documented toxic effects of CSM-7 may not depend on XO activity.

**Key Words:** donkey milk, breast milk, cow milk

**T109 Case study: Comparison of biologically active compounds in milk from organic and conventional dairy herds.** Diane L. Van Hekken\*<sup>1</sup>, Michael H. Tunick<sup>1</sup>, Hubert J. Karreman<sup>2</sup>, Elaine R. Ingham<sup>2,3</sup>, and Peggy M. Tomasula<sup>1</sup>, <sup>1</sup>USDA, ARS, Wyndmoor, PA, <sup>2</sup>Rodale Institute, Kutztown, PA, <sup>3</sup>Soil Foodweb Inc., Corvallis, OR.

Conflicting reports of the quantities of biologically active compounds present in milk from organic grass-fed and conventional herds show that more research is required, especially as these compounds are linked to human health benefits and can improve the health value consumers place on dairy products. In collaboration with the Rodale Institute, Kutztown, Pennsylvania, a 3-year study evaluated the composition of milk obtained from 2 farms adjacent to the Rodale experimental farm: one herd transitioned to certified organic in the first year; cows averaged over 50% dry matter intake from pasture during the grazing season. The other herd was on a confined conventional farm with no access to pasture. This study provided a unique opportunity to compare milk from farms of similar soil types, climate, and weather. Over a 150-week period (3 grazing seasons), weekly milk samples were collected and assayed for composition and physical traits, and profiled for fatty acids (FAs) and proteins-peptides. The overall protein, lactose, ash, minerals, total solids contents, pH, water activity, titratable acidity, and protein profiles of the milk samples from both farms were similar ( $P < 0.05$ ). Fat content was more variable in the milk from the organic herd, especially after the seasonal grazing was implemented, with higher fat levels ( $P < 0.05$ ) obtained during the winter months. The FA profiles were the major difference between the milk from the 2 herds. Compared with the confined herd, the grazing herd milk had considerable variation in the FA profiles, which generally stabilized after 4 mo, and had higher levels ( $P < 0.05$ ) of  $\alpha$ -linolenic acid (omega-3 FA) after the second month. Once certified, the organic herd produced milk that contained 36% more omega-3 FA and had lower linoleic acid (omega-6):omega-3 FA values throughout the year, and 25–30% more conjugated linoleic (CLA) during the grazing seasons than the confined herd. Because higher CLA and omega-3 FA levels and a low omega-6:omega-3 value have been linked to being beneficial to human health, the importance of pasture grazing must be considered in supplying milk and dairy products that address consumers' demand for foods that support human health and wellness.

**Key Words:** milk, organic, omega-3 fatty acids

**T110 Evaluation of the effect of diets containing grape seed and linseed on milk fatty acid composition in Sarda sheep by principal component analysis.** Fabio Correddu, Anna Nudda\*, Giustino Gaspa, Gianni Battacone, and Giuseppe Pulina, *Dipartimento di Agraria, University of Sassari, Sassari, Italy.*

This work aimed was to study the effect of the dietary inclusion of grape seed and linseed, on milk fatty acid (FA) composition in Sarda

dairy sheep. Milk samples were collected weekly from 24 Sarda ewes assigned to 4 dietary treatments: control diet (CON), containing 300 g/d of grape seed (GS), a diet containing 220 g/d of linseed (LIN) and a diet containing both lin- and grape seed (MIX). Samples were analyzed for FA profile with GC. Data of major classes of FA were analyzed by principal component analysis (PCA) and the first 2 PC were retained for further analysis based on the proportion of variance explained by PC. The first and second PC accounted for about 90% of the total variability (78.3% and 12%, PC1 and PC2, respectively). Elements of eigenvector of PC1 were positively associated with unsaturated (0.246), monounsaturated, long, *trans* FA and CLA (0.244, 0.243, 0.233, 0.231), whereas groups characterized by short, medium chain FA, saturated FA showed negative association with PC1 (-0.231, -0.238, -0.246). PC2 loadings were positively correlated with n-6 and n-6/n-3 ratio (0.455, 0.559), and negatively with n-3 (0.470). Furthermore, PC1 presented negative loadings for atherogenic index and thrombogenic index (-0.238, -0.236). It was supposed that PC1 was positively associated with the PUFA intake, which progressively increased in CON, GS, LIN and MIX. PC2 could be related to the different source of PUFA (grape seed or linseed) and consequently, with the ratio PUFA n-6/n-3 in the diet. The observations plotted on the new system of variables defined by PC1 and PC2, revealed definite clusters for each of the 4 dietary treatments. Incremental scores in PC1 were observed for CON, GS, LIN and MIX, (-5.8, -0.3, 1.5, 4.5, respectively); PC2 discriminated only GS (positive scores, 1.9) from LIN (negative scores, -2.0). Overall, the results suggest that the inclusion of grape seed and linseed in the diet of lactating ewes could be useful to improve the quality of milk FA, especially when used in combination. The PCA has shown to be a useful tool for understanding the effect of different dietary treatments on milk FA profile.

**Key Words:** grapeseed, milk fatty acid, multivariate analysis

**T111 Interaction between whey protein and inulin in model system.** Cuina Wang<sup>1</sup>, Hao Wang<sup>1</sup>, and Mingruo Guo<sup>1,2</sup>, <sup>1</sup>*Jilin University, Changchun, Jilin, China*, <sup>2</sup>*University of Vermont, Burlington, VT*.

Effects of protein concentration (4–8%, w/v), inulin concentration (1–5%, w/v) and ionic strength (10–50 mM) on Ca<sup>2+</sup>-induced interactions between whey protein (WP) and inulin mixture (pH 7.0) heated at 85°C for 30 min were investigated. The interactions were analyzed for turbidity, particle size, zeta potential, apparent viscosity, and texture profile. Interaction properties were also compared with mixture of polymerized whey protein (PWP) and inulin in which whey protein was heated first and then mixed with inulin. Results indicated that the dispersion became more opaque with increasing protein but no significant difference was detected regarding the way inulin added ( $P < 0.05$ ). Three peaks at about 40, 900 and 5000 nm were observed in size distribution by volume. Compared with the control, there was a small shift toward larger size with increasing inulin level in the width of peak corresponding to denatured whey protein. Zeta potential values for all samples fell in the ranges of -10 to -30 mV independent of the manner in which inulin added. Increasing inulin resulted in less negative zeta potential and smaller repulsive force between particles for both types of mixtures. As protein and inulin increased, apparent viscosity increased and combination of PWP and inulin showed significant higher values ( $P < 0.05$ ) than WP and inulin mixture. It was not sufficient to form cold gels for all samples at the level of 10 mM Ca<sup>2+</sup>. Compared with the control, the mixtures of PWP with inulin showed higher water holding capacity may due to the ability of occluding water of inulin microcrystals ( $P < 0.05$ ). WP/inulin mixture showed significant higher hardness ( $P < 0.05$ ) than PWP/inulin due to possible microcrystal seeds maintained in solu-

tions when heated at 80°C for 30 min. Results indicated that interactions maybe occurred between whey protein and inulin in the model system.

**Key Words:** whey protein isolate, polymerized whey protein, inulin

**T112 Characterizing the dissolution behavior of whey protein concentrate with an ultrasonic flaw detector.** Mary Hauser\* and Jayendra Amamcharla, *Kansas State University, Manhattan, KS*.

Current methods used in the dairy industry to characterize the dissolution process are difficult to reproduce and subjective. Low-intensity ultrasound spectroscopy has the advantage of being rapid and precise, but the equipment is expensive. An ultrasonic flaw detector (UFD) is an economical alternative and allows for rapid data collection at a single frequency. This study focused on characterizing the dissolution behavior of whey protein concentrate (WPC) with an UFD. The experimental setup included an UFD (Epoch LTC) in pulse-echo mode and a 1MHz immersion transducer. Two batches of WPC80 from a commercial manufacturer were stored at 25°C and 40°C for 3 weeks. 19.74g of WPC was gradually added to 375g water. The tests were performed in duplicate. During dissolution, ultrasonic (US) data from UFD, chord length distribution from focused beam reflectance measurement (FBRM), and solubility index were collected at regular intervals for 1800s. US relative velocity and attenuation were calculated from A-scan data obtained from the UFD. The relative velocity was defined as the ratio of the US velocities of WPC solution and water at 40°C. It was observed that fresh WPC had a relative velocity of 1 after 1800s. The relative velocity at 1800s increased for powders stored at 25°C and decreased for powders stored at 40°C. After 3 weeks of storage at 25°C and 40°C, the relative velocities were 1.015 and 0.98, respectively. Attenuation had a general trend of increasing and then gradually decreasing. The storage temperature of WPC influenced the time to reach the peak and the area under the attenuation curve. Fresh powders reached the peak after 1440s. Three weeks of storage at 25°C and 40°C caused the peak time to increase to 1658s and decrease to 986s, respectively. The area had a similar trend. Fresh powders had an area of 60Np\*s/m. Powders stored at 25°C and 40°C for 3 weeks had areas of 47Np\*s/m and 91 Np\*s/m, respectively. Storage temperature significantly ( $P < 0.05$ ) effected relative velocity at 1800s, peak time, and area. FBRM data showed that powders stored at 40°C for 3 weeks had larger particles. Overall, a UFD can be a useful tool when characterizing the dissolution behavior of WPC.

**Key Words:** ultrasonic flaw detector, whey protein concentrate

**T113 Effect of pH and Ca-ion activity on the heat stability of reconstituted reduced Ca milk protein concentrate dispersions.** Gopinathan H. Meletharayil<sup>1</sup>, Anil Kommineni\*<sup>1</sup>, Chenchaiiah Marella<sup>2</sup>, and Lloyd E. Metzger<sup>1</sup>, <sup>1</sup>*Midwest Dairy Foods Research Center, Dairy Science Department, South Dakota State University, Brookings, SD*, <sup>2</sup>*Idaho Milk Products, Jerome, ID*.

The purpose of this study was to investigate the heat stability and calcium ion activity of the reconstituted MPC dispersions. Reduced calcium MPC (RCMPC) powders were produced from skim milk subjected to CO<sub>2</sub> treatment before and during the process of ultrafiltration. The CO<sub>2</sub> injection was controlled to obtain 0, 20, 30, and 40% reduction in Ca levels of MPC powders. RCMPC powders were reconstituted to 10% protein in deionized water. These dispersions were tested for heat stability in a rocking oil bath at 140°C at unadjusted, 6.5, 6.7, 6.9, and 7.1 pH. Calcium ion activity (CIA) and ionic strength measurements on Ca-standards and all dispersions were carried out using a Ca ion-selective electrode and conductivity meter. The unadjusted pH of the dispersions

varied from 6.8 in control to 5.95 in 40% RCMPC dispersions. This pH difference had an effect on the CIA of the dispersions and ranged from 1.31mM in control to 18.39mM in 40% RCMPC dispersions. Differences in the heat stability were observed in the unadjusted pH dispersions with the control MPC having the highest heat stability that decreased as the percentage of Ca reduction increased. The heat stability of control MPC dispersions showed a minimum at pH 6.7 and maximum at pH 6.9 with a decrease observed at pH 7.1. The CIA of RCMPC dispersions decreased with an increase in pH. A steady increase in the heat stability of 30 and 40% RCMPC dispersions was observed with increase in pH which correlated with decrease in the calcium ion activity. Dispersions from 20% RCMPC showed a heat stability profile similar to the control MPC dispersion but had higher heat stability values at all adjusted pH values. The CIA activity had a direct correlation on the heat stability of the unadjusted MPC dispersions, but at a higher pH of 7.1, no correlation was evident, even though, all the dispersions had a low CIA. Heat stability of 30 and 40% RCMPC dispersions increased with an increase in the pH showing highest heat stability at a pH of 7.1. From this study, it can be concluded that pH and Ca-ion activity influences the heat stability of RCMPC dispersions.

**Key Words:** milk protein concentrate, Ca ion activity, heat stability

**T114 Rennet coagulation and cold gelation properties of recombined highly concentrated micellar casein concentrate and cream.** Ying Lu<sup>\*1</sup>, Donald McMahon<sup>1</sup>, Lloyd Metzger<sup>2</sup>, Anil Kommineni<sup>2</sup>, and Almut Vollmer<sup>1</sup>, <sup>1</sup>Western Dairy Center, Utah State University, Logan, UT, <sup>2</sup>Midwest Dairy Foods Research Center, South Dakota State University, Brookings, SD.

Highly concentrated micellar casein concentrate (HC-MCC), a potential ingredient for cheese making, containing ~20% casein with ~70% of whey proteins removed by microfiltration, and diafiltration of skim milk, and then further concentrated by vacuum evaporation. Our objective was to investigate rennet coagulation and cold gelation properties of recombined thawed frozen HC-MCC and cream under different conditions. The HC-MCC was recombined with cream using low shearing at 50°C for 30 min, followed by rheological measurements. Cold gelling temperature [the temperature at which storage modulus ( $G'$ ) = loss modulus ( $G''$ )], was positively correlated with casein levels from 8.6% to 11.5% ( $R^2 = 0.71$ ) and pH from 6.6 to 7.0 ( $R^2 = 0.96$ ). Gelation occurred at ~-35, ~-26 and ~-13°C with 11%, 10% and 9% casein concentration, respectively. This process was reversible with a hysteresis effect observed depending on whether the mixture was being heated or cooled. Rennet coagulation of HC-MCC and cream mixture at rennet level of 20 mg/100 g was studied by testing coagulation time (CT, the time when  $G' = G''$ ) and curd firming rate (the ratio of  $G'$  at 1.5 times of coagulation time and at coagulation time). Increasing casein level from 3.3 to 10.9% significantly increased ( $P < 0.001$ )  $G'$  from 0.1 to 2 Pa, and slightly reduced CT ( $P < 0.05$ ) by 1.3 min from casein level from 3.3% to 5.7%, without change of CT at higher casein level. Decreasing pH of mixture from 6.6 to 6.2 significantly reduced CT ( $P < 0.001$ ) by 5.5 min, and increased firming rate ( $P < 0.05$ ) from 35 to 107. Decreasing coagulation temperature from 31 to 25°C significantly decreased firming rate ( $P = 0.001$ ) from 160 to 76, increased CT ( $P < 0.001$ ) by 2 min, and  $G'$  ( $P < 0.05$ ) from 2 Pa to 4 Pa. Addition of citrate to the mixture significantly decreased ( $P < 0.05$ ) firming rate from 35.2 to 4.6, increased  $G'$  ( $P < 0.05$ ) from 3 Pa to 6 Pa, with no significant effect ( $P > 0.05$ ) on CT. Therefore, decreasing coagulation temperature, or adding citrate may make rennet coagulation properties of recombined HC-MCC and cream at high casein level more suitable for cheese making by increasing coagulation time and reducing curd firming rate. Understanding rennet coagulation and

cold gelation properties can help potentially use recombined HC-MCC and cream for cheese making.

**Key Words:** rennet coagulation, micellar casein, microfiltration

**T115 Formation of sodium caseinate-maltodextrin conjugates and the rheological properties of acid gels.** Shuwen Zhang<sup>\*1,2</sup>, Yuansheng Gong<sup>1</sup>, Som Khanal<sup>1</sup>, Yanjie Lu<sup>1</sup>, and John A. Lucey<sup>1</sup>, <sup>1</sup>Department of Food Science, University of Wisconsin-Madison, Madison, WI, <sup>2</sup>Institute of Agro-Product Processing Science and Technology, Chinese Academy of Agricultural Sciences, Beijing, China.

Conjugation of polysaccharides to proteins utilizing the Maillard reaction leads to significant improvement in the functional properties of proteins, such as solubility, emulsification, and thermal stability. However, no gelation properties of conjugates have previously been reported. In this study, we studied the conjugation reaction between sodium caseinate (NaCN) and maltodextrin100 (Md100) in aqueous solutions via the initial stage of the Maillard reaction. The rheological properties of acid-induced gels made from NaCN-Md conjugates prepared by Maillard reaction were investigated. Acidification was performed by the addition of glucono-delta-lactone at 30°C. Covalently linked conjugates of NaCN and Md100 were produced by incubating aqueous solutions containing 5% NaCN and 5% Md100 at 90°C for 10 h. The covalent attachment of Md100 to NaCN was confirmed by SDS-PAGE with both protein and carbohydrate staining. The Schiff base formation of NaCN-Md conjugates was monitored by maximum absorbance peak at ~300 nm using UV spectroscopy. Conjugation resulted in faster gelation (higher pH) but lower storage modulus and shear stress values of acid gels compared with gel made with NaCN only. An increase of loss tangent was also observed in acid gel made with conjugates. These results indicate that conjugates modify protein gelation and a potential use for these NaCN-Md could be as specialty functional food ingredients.

**Key Words:** sodium caseinate, maltodextrin, conjugate

**T116 Edible packaging films from calcium-caseinate and citric pectin.** Laetitia M. Bonnaille\* and Peggy M. Tomasula, USDA/ARS/NEA/ERRC, Wyndmoor, PA.

Casein-based films have excellent gas-barrier properties and strength appropriate to form a variety of edible food packaging, but do not constitute strong moisture barriers. In prior work, we used humidity-controlled DMA (DMA-RH) to show that solvent-cast films from calcium caseinate (CaCas, 75% dry basis) and glycerol plasticizer (Gly, 25% dry basis) of 0.03–0.05 mm thickness are extremely sensitive to ambient relative humidity (RH) and temperature (T) and melt around  $T_m \sim 45^\circ\text{C}$  at 50% RH, or  $RH_m \sim 67\%$  at 20°C;  $T_m$  also decreases at higher RH, which limits the usefulness of CaCas packaging films in warm and/or humid conditions. Citric pectin (CP, 0.1 to 2% dry basis) was explored as an edible additive to crosslink CaCas/Gly films with the objective to improve their environmental resistance. CP was added to water/Gly solutions, stirred for 1h, then CaCas was added and stirred for 1 h. Dynamic T-ramps (10–70°C) with an AR2000 rheometer showed that at 25°C, CP% strongly increased the viscosity and storage modulus,  $G'$ , of the solutions near-exponentially, signifying strong binding of CP with CaCas; in addition, new crosslinks were activated between ~42–60°C for 1–2% CP. DMA-RH (Q800) T-ramps of dried films at 50% RH showed that 0.1–0.5% CP softened the films and reduced  $G'$  due to steric hindrance of isolated CP particles throughout the CaCas network, while

1 to 2% CP increased  $G'$ , demonstrating a higher crosslink-density in the films.  $T_m$  increased to  $\sim 50^\circ\text{C}$  with 1% CP and  $\sim 60^\circ\text{C}$  with 2% CP. Optical microscopy imaging confirmed strong changes in the CaCas/Gly/CP network as a function of CP content. Moisture sorption RH-ramps at  $20^\circ\text{C}$  (Q5000SA) indicated that CaCas films absorb  $\sim 10\%$  of their weight in water at 50% RH and up to  $\sim 28\%$  at 80%RH; adding up to 2% CP reduced water-sorption by up to 15% at high RH. High CP% (0.75–2%) slowed dissolution kinetics of the films in water at  $20^\circ\text{C}$ , while low CP% (0.1–0.5%) accelerated solubilization slightly. CaCas films strengthened with  $> 1$ –2% CP are more environmentally-resistant and have the potential to replace or improve some synthetic food packaging to reduce waste and/or add functionality and nutrition to food products.

**Key Words:** casein, hydrophilic film, dynamic rheology

#### **T117 Changes in volatile compounds in whey protein concentrate stored at elevated temperature and humidity.**

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Whey protein concentrate (WPC) has been recommended for use in emergency aid programs, but it is often stored overseas without temperature and relative humidity (RH) control, which may cause it to be rejected because of yellowing, off-flavors, or clumping. Therefore, the volatile compounds present in 14.0-kg bags of WPC34 (36% protein) and 18.7-kg bags of WPC80 (79% protein) were analyzed during storage over 18 mo in environmental chambers at 25, 30, and  $35^\circ\text{C}$  at RH levels of 70, 80, and 90%. An ambient chamber at around  $21^\circ\text{C}$  and 45–65% RH served as the control. The concentrations of dimethyl disulfide increased with time as the sulfur-containing amino acids cysteine and methionine were degraded. Five aldehydes (hexanal, heptanal, octanal, nonanal, and benzaldehyde) and 2 ketones (2-butanone and 2-heptanone) appeared as a result of lipid oxidation. Lactose breakdown led to the presence of butanol, hexanol, and furaneol. The levels of volatiles were higher in the WPC80 and tended to increase with temperature and RH. Although the color and flow properties were affected by the conditions, the generation of volatile compounds did not have a noticeable effect on product odor.

**Key Words:** whey protein concentrate, volatile compounds

#### **T118 Characterization of milk, soymilk, and almond milk through consumer affective and emotional responses.**

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Plant-based milk beverages, notably soymilk and almond milk, are competing with dairy milk in the refrigerated retail case. It is unknown if product sensory differences affect consumer behaviors and purchasing decisions. Dairy and plant-based milk beverages were evaluated for acceptability and characterization of product attributes and emotional response for dairy milk, almond milk, soymilk, and soymilk with added titanium dioxide for whitening. We hypothesized that appearance would affect acceptability; soymilk treatments and almond milk, with a darker visual appearance, would have different acceptability and emotional characterization than dairy milk. Untrained panelists ( $n = 49$ ) received each product for evaluation of overall acceptability, just-about-right (JAR) scale, and check-all-that-apply (CATA) emotional terminology

(EsSense) ballot. Mean acceptability of all treatments was between “neither like or dislike” and “like slightly” on a 9-point hedonic scale (mean = 5.33); however, all products appeared to have bimodal distributions. CATA emotional terms calm, content, good, and mild were chosen by  $>20\%$  of panelists (frequently selected terms) for all treatments. Of the frequently selected terms across products, calm was selected less for soymilk, good was chosen more for almond milk, and the terms happy and pleasant were not chosen for dairy milk. Mild (almond, soymilk with titanium dioxide, and dairy milk) and quiet (soymilk, soymilk with titanium dioxide) terms were associated with decreased hedonic score based on penalty life analysis. Pleased (soymilk) and satisfied (dairy milk) were most closely associated with high hedonic scores. Dairy milk had a more optimal appearance than all plant-based milk products based on JAR characteristics. Almond milk and soymilk have different product characteristics than dairy milk, based on JAR, that influence acceptability. Plant-based beverages, while competing for shelf-space in the dairy retail case, do not match consumer just-about-right expectations for sensory quality as well as dairy milk. Understanding consumer emotional perception of dairy milk compared with plant based milk beverages can add value to marketing and promotion of fluid milk in a competitive beverage market.

**Key Words:** milk, emotions, just-about-right scale

#### **T119 Effect of storage temperature on physico-chemical and sensory attributes of ready-to-drink breakfast smoothie.**

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Shelf-life is an important consideration for ready-to-drink (RTD), long-shelf-life beverages such as smoothie. For any new product, product developer would be interested to know the shelf-life of the products when stored at different temperature. The objective of the present study was to determine the physico-chemical and sensory stability of formulated smoothie at 3 different temperatures ( $4^\circ\text{C}$ ,  $30^\circ\text{C}$  and  $40^\circ\text{C}$ ). Sensory analysis using trained panel as well as physico-chemical attributes such as expressible serum (ES), acidity, pH, viscosity were studied to determine the shelf-life. An expert panel consisting 10 member evaluated the products for its color and appearance (C&A), flavor, consistency, sweetness and overall acceptability (OA) based on 9-point hedonic scale at the interval of every 15 d. Effect of storage period on acceptability of smoothie at 3 different temperatures was analyzed using IBM SPSS 20 software and study was done in triplicate. ES and acidity values were increased significantly ( $P < 0.05$ ) at all temperatures during storage and highest increment for both parameters were found at  $40^\circ\text{C}$  while lowest increment were at  $4^\circ\text{C}$ . Viscosity was increased during storage at  $4^\circ\text{C}$  but reduction was found at rest of 2 temperatures ( $P < 0.05$ ). pH of product decreased at all temperatures significantly ( $P < 0.05$ ). Sensory attributes; C & A, flavor, sweetness and OA scores were significantly ( $P < 0.05$ ) reduced during storage at all temperatures. Highest reduction in scores was found at  $40^\circ\text{C}$  while lowest reduction was at  $4^\circ\text{C}$ . In case of consistency, score was increased during storage at  $4^\circ\text{C}$  while reduction in score was observed at  $30^\circ\text{C}$  and  $40^\circ\text{C}$  ( $P < 0.05$ ). Shelf life studies revealed that the product remained an acceptable up to 90, 75 and 60 d at  $4^\circ\text{C}$ ,  $30^\circ\text{C}$  and  $40^\circ\text{C}$  respectively.

**Key Words:** ready-to-drink, smoothie, storage study

#### **T120 Physico-chemical profile and mineral content of yogurts and whey beverages available in the Brazilian market.**

Thaiza Serrano, Simone Lorena, Adriano Cruz, and Renata Raices\*, Federal

The physico-chemical profile and the minerals content in yogurt and whey beverage marketed in Brazilian market were investigated. Twenty samples (Ten yogurt and 10 whey beverages) presented in the label Federal Inspection Service (SIF) were submitted to physicochemical analysis (moisture, proteins and lipids levels) minerals contents (Ca, Fe, K, Mg, Na, Cd, Cr, Cu, Mn and Pb) being the latter identified and quantified from Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). Absence of difference was noted in moisture content, as the yogurt samples presented mean value  $82.12 \pm 0.21\%$  while and the dairy beverages presented  $83.08 \pm 0.06\%$  w/w ( $P > 0.05$ ). Both products presented protein content of yogurt above the minimum required by the legislation ( $4.87 \pm 0.42\%$  w/w and  $2.72 \pm 0.13\%$  w/w, yogurt and whey beverage, respectively) which present an advantage on the nutritional point of view. Regards the lipid levels, the yogurt presented high values compared with whey beverages ( $2.00 \pm 0.07$  and  $1.23 \pm 0.06\%$  w/w, respectively,  $P < 0.05$ ). Calcium was the mineral with the highest concentration in both product categories (mean values  $1.36 \pm 0.36$  and  $1.07 \pm 0.36$  mg/g, respectively,  $P < 0.05$ ), followed by potassium (mean values  $1.60 \pm 0.29$  and  $1.41 \pm 0.21$  mg/g, respectively,  $P > 0.05$ ), sodium (mean values  $0.74 \pm 0.15$  and  $0.68 \pm 0.09$  mg/g, respectively,  $P > 0.05$ ), magnesium (mean values  $0.16 \pm 0.04$  and  $0.11 \pm 0.01$  mg/g, respectively,  $P > 0.05$ ) and iron ( $0.01 \pm 0.00$  mg/g for both products categories). It was not detected minority constituents (Cd, Cr, Cu, Mn and Pb), in both products.

**Key Words:** yogurt, whey beverage, characterization

**T121 Probiotic fermented milk with banana flour: Understanding the prebiotic effect.** Aline Silva, Renata Raices, Marcia Cristina, Luciana Nogueira, and Adriano Cruz\*, *Federal Institute of Science and Technology of Rio de Janeiro (IFRJ), Rio de Janeiro, Brazil.*

This study aimed to investigate the effect of adding increased amounts of banana flour (0, 0.5, 1.5 e 3 w/w %, I, II, III, IV) in probiotic fermented milk processing. Microbiological (*Streptococcus thermophilus*, *Lactobacillus acidophilus* and *Bifidobacterium* counts), Physico-chemical analysis (gross composition, resistant starch, pH, proteolysis and firmness) were performed weekly along 21 d. While *S. thermophilus* presented always values about 8 log cfu/g for all samples, probiotic microorganisms presented different behavior. While *L. acidophilus* presented a decrease in the viable counts in the samples added with 3 w/w % banana flour (from 8.03, d 1, to 7.14 log cfu/g, d 21,  $P < 0.05$ ), *Bifidobacterium* present increase along the storage time (6.78, d 1 to 7.14 log cfu/g, d 21,  $P < 0.05$ ). Toward the physico-chemical parameter, pH did not present difference among the samples and related to storage time (values ranged 4.60 to 4.67,  $P > 0.05$ ), while increased proteolysis level was observed at the fermented milks added with intermediate levels of banana flour (values ranged from 0.430 to 0.667, sample II and 0.455 to 0.662, sample III) in relation to sample III (values ranged from 0.345 to 0.378,  $P < 0.05$ ). For the firmness, it was observed direct relation with the banana flour addition (values ranged to 1.23, sample I to 1.88 N, sample IV) without relation to the storage time. The gross composition reported absence of difference among the fat and proteins levels while for resistant starch content, sample III presented increased decrease (30.11%) compared with sample IV (20.07%), respectively. Our findings suggest the need to adjust the banana flour dosage during

probiotic fermented milk processing as well as the probiotic culture to be added at the formulation to obtain the prebiotic effect.

**Key Words:** banana flour, probiotic fermented milk

**T122 Probiotic yogurt with glucose oxidase: Performance with commercial products and potential advantages.** Aline Batista, Marcia Silva\*, Renata Raices, Luciana Nogueira, and Adriano Cruz, *Federal Institute of Science and Technology of Rio de Janeiro (IFRJ), Rio de Janeiro, Brazil.*

The quality parameters of probiotic yogurt with addition of glucose oxidase (250 and 500 ppm, GOXI and GOXII) compared with commercial products available in the Brazilian market were investigated. Microbiological (probiotic bacteria count), physical-chemical (pH, proteolysis) and metabolic activities (production of organic acids, flavor and aroma compounds and fatty acid profile) were performed. High counts were observed for all microorganisms, with values above 9 log cfu/mL for *S. thermophilus*, and 8 log cfu/mL for *L. bulgaricus*, *L. acidophilus*, and *Bifidobacterium* ( $P > 0.05$ ). In addition, they presented lower post-acidification values and the highest proteolysis values, which ranged from 4.17 to 4.21 and 0.796 to 0.788, respectively,  $P < 0.05$ ), as well as exhibited similar results for lactic acid and acetic acid (from 1.34 to 1.37, and 0.72 to 0.79 mg/mL,  $P > 0.05$ ), and higher values for diacetyl and acetaldehyde. Regards the fatty acid profile, it were observed intermediate values for short- and medium-chain fatty acids (SCFA and MCFA, in the range of 1.82 to 2.20, and 16.3 to 17.07 g/100 g lipids,  $P < 0.05$ ) and higher values for long-chain fatty acids especially for the yogurt GOX1 (LCFA, in the range of 80.73 to 81.92 g/100 g lipids,  $P > 0.05$ ). In addition the yogurt GOX1, presented higher values for monounsaturated and polyunsaturated fatty acids (MUFA and PUFA, in the range of 30.14 to 34.26, and 4.04 to 4.12 g/100 g lipids,  $P < 0.05$ ), as well as, higher values for trans-vaccenic acid and for linolenic and conjugated linoleic acids (C18:1t, C18:2 and CLA, in the range of 3.71 to 3.72, 2.84 to 2.89, and 1.28 to 1.27 g/100 g lipids, respectively,  $P > 0.05$ ). In a functional food perspective, the addition of glucose oxidase to probiotic yogurts may be an interesting technological option for small and medium-size dairy enterprises to enter to the market of functional dairy foods.

**Key Words:** probiotic yogurt, glucose oxidase

**T123 Physical characteristics of set-type probiotic yogurt produced from mixtures of cow and sheep milk.** Felipe S. Vianna, Celso Fasura Balthazar\*, and Adriana C. O. Silva, *Department of Food Technology, Veterinary College, Federal Fluminense University, Niterói, Rio de Janeiro, Brazil.*

Bovine milk is the most important from commercial and industrial point of view, because the milk supplied from cows is cheaper and more plentiful than sheep milk. Thus, large-scale industrialization of the dairy sheep sectors in many countries is limited by low volume and seasonal cyclicality of individual milk production. As well, it is known that milk is more rich in milk total solid than bovine milk and has interesting features concerning texture technological aspects, thus this milk is used to produce dairy products. To combine the benefits of sheep milk plus the more affordable bovine milk, the purpose of this study was to develop a functional set-type probiotic yogurt from the mixture of cow and sheep milk, to establish a comparison among the mixtures (25/75; 50/50; 75/25 v/v sheep/cow milk) and control treatments through evaluation of yogurt physical composition. Sheep milk yogurt (SMY) obtained the highest ( $P < 0.05$ ) firmness value. Thus, an increase in the

amount of sheep milk for yogurt increased the firmness of mixtures. Different sheep milk ratios in cow milk did not influence ( $P < 0.05$ ) the apparent viscosity of the yogurt mixtures. Concerning the water-holding capacity, SMY obtained the highest values, whereas CMY exhibited the lowest values ( $P < 0.05$ ). The yogurts produced with mixed milk (50/50 v/v) presented an intermediate value when compared with the other treatments. All treatments presented significant differences in syneresis index and the greater the amount of sheep milk in the yogurt resulted in lower index of syneresis. Thus intermediate mixed milk yogurts showed satisfactory results for physical analyses.

**Key Words:** firmness, sheep milk, water-holding capacity

**T124 Physical characteristics of set-type yogurts produced using milk from different ruminants species.** Felipe S. Vianna, Celso Fasura Balthazar\*, and Adriana C. O. Silva, *Department of Food Technology, Veterinary College, Federal Fluminense University, Niterói, Rio de Janeiro, Brazil.*

Most published studies involving dairy products used cow milk because of large volume and economic importance, however, many countries with specific climatic (desert) and terrain features (mountainous terrain) favor dairy goat and sheep farming, making this activity essential for national economy. The present study purpose was to compare physical properties of yogurts obtained from sheep (SMY), cow (CMY) and goat (GMY) milk for 28 d of storage. This research found that SMY were firmer ( $P < 0.05$ ) than those of CMY and GMY. The firmness of CMY was greater ( $P < 0.05$ ) than GMY in the 14th and 28th day of storage. In most of cases, the firmness was not altered by the storage time. Apparent viscosity varied depending on the type of milk used to produce yogurts. The apparent viscosity (AV) of SMY was higher ( $P < 0.05$ ) than CMY and GMY at 14th and 28th day. Moreover, CMY had greater ( $P < 0.05$ ) levels of viscosity than GMY. There was not, however, a significant difference during storage ( $P < 0.05$ ) for each yogurt type. The water-holding capacity (WHC) of GMY were lower ( $P < 0.05$ ) than that obtained from CMY and SMY, which had the highest levels. Furthermore, there was no influence in this ratio during the storage time ( $P < 0.05$ ). The syneresis index (SI) was significantly affected by the milk type, however it was not altered by the storage time ( $P < 0.05$ ). In contrast with WHC, the lowest syneresis was observed in SMY than in CMY and GMY. Therefore, SMY achieved the greater firmness, AV and WHC, with lower SI than CMY and GMY. On the other hand, despite the proximate composition of CMY being similar to GMY, GMY generally had the lowest firmness, AV and WHC, but highest SI.

**Key Words:** cow milk, goat milk, sheep milk

**T125 Fatty acid profile in prebiotic sheep milk yogurt.** Celso Fasura Balthazar\*, Jeremias Moraes<sup>2</sup>, Hugo Leandro A. Silva<sup>1</sup>, Renata S. L. Raices<sup>2</sup>, and Adriano G. Cruz<sup>2</sup>, *Department of Food Technology, Veterinary College, Federal Fluminense University, Niterói, Brazil, <sup>2</sup>Instituto Federal de Educação, Ciência e Tecnologia do Rio de Janeiro, Rio de Janeiro, Brazil.*

The fatty acids (FA) present in sheep milk have beneficial compounds, which might prevent cardiovascular diseases. Inulin fiber was added to sheep milk to enhance the prebiotic biological effects to this milk. This study aimed to verify the FA profile, atherogenic (AI) and thrombogenic indices (TI) in prebiotic sheep milk yogurt (PSMY) with added inulin (0, 2, 4 and 6%) during 28 d of storage. Thus, CLA *trans*-10,*cis*-12 were detected, but below qualification limit, meaning they were in low amounts in PSMY. The predominant FA were palmitic, oleic, myristic

and capric. There was an increase ( $P < 0.05$ ) of saturated fatty acids (SFA) during storage in PSMY. Therefore, palmitic appeared with approximately 33% (C16:0 and SFA:  $r = 0.582$ ), myristic with approximately 20% (C14:0 and SFA:  $r = 0.894$ ) and capric with approximately 16% (C10:0 and SFA:  $r = 0.929$ ). Oleic acid indicated an antiatherogenic (C18:1n9 and AI:  $r = -0.845$ ) and antithrombotic (C18:1n9 and TI:  $r = -0.897$ ) properties and represented around 92% of MUFA. CLA *cis*-9,*trans*-11 represented approximately 78% of PUFA and 2% of FA, which indicated that PSMY are a great source of it. There could be a direct link between CLA and oleic acid ( $r = 0.978$ ), as well CLA increased ( $P < 0.05$ ) along storage. Still, ALA was present in low levels, corresponding to about 22% of PUFA and 1% FA. There was a drop ( $P < 0.05$ ) in ALA level at the first storage measure, which was maintained until the last storage measurement. ALA has nutritional importance due to its anti-thrombogenic effect. PSMY might be considered a food with low atherogenic and thrombogenic risk, because of the low levels of AI and TI. Plus, sheep milk yogurt may have beneficial prebiotic effects with inulin addition.

**Key Words:** CLA, fermented milk, inulin

**T126 Acidity in sheep milk yogurt: The inulin effect.** Celso Fasura Balthazar\*, Rodrigo B. A. Oliveira<sup>1</sup>, and Adriano G. Cruz<sup>2</sup>, *Department of Food Technology, Veterinary College, Federal Fluminense University, Niterói, Brazil, <sup>2</sup>Instituto Federal de Educação, Ciência e Tecnologia do Rio de Janeiro, Rio de Janeiro, Brazil.*

The widespread inulin use in food industry is based on their technological and nutritional properties. This study analyzed pH, titratable acidity (TA), lactose and lactic acid in prebiotic sheep milk yogurt (PSMY), with different inulin content (0, 2, 4 and 6%) immediately after incubation and during 28 storage days at  $4 \pm 2^\circ\text{C}$ . The bacteriological count was performed at the 1st and 28th days of storage. On the 1st day, *Streptococcus thermophilus* counts were: 9 log, 10 log, 11 log, 11 log cfu.  $\text{mL}^{-1}$ , whereas *Lactobacillus delbrueckii* subs. *bulgaricus* were 8 log, 8 log, 8 log, 9 log cfu.  $\text{mL}^{-1}$ . On the 28th day, *S. thermophilus* were 8 log, 8 log, 8 log, 9 log cfu.  $\text{mL}^{-1}$ , and *L. bulgaricus* were 6 log, 7 log, 7 log, 7 log cfu.  $\text{mL}^{-1}$  for PSMY treatments, respectively. There was a significant decrease ( $P < 0.05$ ) in both lactic acid bacteria during storage, due to inulin protective effect. As expected, the pH decreased and TA increased significantly (pH and TA:  $r = -0.835$ ;  $P < 0.05$ ) of PSMY during storage. There was a significant difference ( $P < 0.05$ ) between PSMY with different inulin content, being 0% the most acidic and 6% the less acidic. As well, pH values were not significantly influenced ( $P < 0.05$ ) by the inulin addition. Lactose had a significant decrease ( $P < 0.05$ ) expected through storage ( $r = -0.759$ ) in PSMY. Inulin content had a significant impact ( $P < 0.05$ ) in lactose concentration, because lactose amount was higher in PSMY 6%, dropping in each treatment until PSMY 0%, which had a significantly lower concentration ( $P < 0.05$ ) of lactose during measurement days. This statement suggested that the acid lactic bacteria consumed inulin instead of lactose proportionally with inulin amounts, meaning that lactose was proportionally degraded by lactic acid bacteria into lactic acid (lactose and lactic acid:  $r = -0.826$ ). Thus, lactic acid concentration of PSMY 0% was higher ( $P < 0.05$ ) compared with others. Lactic acid had a significant increase during storage ( $r = +0.936$ ;  $P < 0.05$ ) in PSMY. Moreover, inulin amount delayed the acidity increase in PSMY (lactic acid and TA:  $r = +0.919$ ), suggesting that inulin fiber retarded the acidity growth in yogurts, which is pleasant for consumer and dairy industry.

**Key Words:** ferment milk, inulin, lactic acid.

**T127 A clean label approach for manufacture of yogurts using tailored milk protein interactions.** Gopinathan H. Meletharayil\* and Hasmukh A. Patel, *South Dakota State University, Brookings, SD.*

Tailoring protein interactions can be used as a strategy to improve textural properties that can potentially replace stabilizers in yogurts. The objective of the present study was to investigate the influence of functionalized milk proteins in yogurt formulations of varying protein content on the rheological and textural properties of yogurt. Functionalized retentate (FUR) was obtained by injecting CO<sub>2</sub> prior to and during the ultrafiltration of skim milk (SM) at ~10°C. Control and test yogurt formulations containing 3.0, 4.0 and 5.0% w/w of total protein were prepared with control containing proteins from SM and test formulations containing proteins from SM and FUR at 1:1 protein ratio. Formulations were heated at 90°C for 10 min, followed by cooling to 42°C. Following inoculation with yogurt culture, formulations were incubated at 42°C for 4 h in cups. After overnight storage at 4°C, the samples were analyzed for hardness using a texture analyzer and flow behavior using a rheometer. Experimental data were tested for ANOVA and statistical significance ( $P < 0.05$ ) was determined, using statistical software SAS. The hardness values significantly increased ( $P < 0.05$ ) from 189, 305 and 426 g in control yogurts to 236, 351 and 511 g in yogurts containing functional proteins at 3.0, 4.0 and 5.0% protein respectively. Similarly, the consistency coefficient, K, increased significantly ( $P < 0.05$ ) from 6.1, 10.3 and 18.7 Pa.S<sup>n</sup> in control yogurts to 10.68, 21.2 and 25.80 in yogurts containing functionalized milk proteins. Apparent viscosity ( $\eta_{70}$ ) significantly increased ( $P < 0.05$ ) from 0.45, 0.67 and 1.1 Pa.S in control yogurts to 0.51, 1.08 and 1.25 Pa.S in yogurts containing functional milk proteins at 3, 4, and 5% protein respectively. These results showed that there was an increase in the hardness, consistency coefficient and apparent viscosity of yogurts containing functionalized milk protein at all the three protein levels, which could be attributed to greater protein interactions in the serum phase. The results of the present study clearly indicate that the use of functionalized milk in yogurt formulation can be used as a potential approach to replacing stabilizers such as gelatin in yogurts and thus achieving a step towards clean label products

**Key Words:** clean label, yogurt, carbon dioxide

**T128 Application of computing technology in simulation of consumer acceptance of typical hard ice creams during storage** Maryam Bahram-Parvar\*<sup>1,2</sup>, Fakhreddin Salehi<sup>2</sup>, and Seyed Razavi<sup>2</sup>, <sup>1</sup>*University of Guelph, Guelph, ON, Canada,* <sup>2</sup>*Ferdowsi University of Mashhad, Mashhad, Khorasan Razavi, Iran.*

Sensory evaluation is widely used in the food industry, especially for quality inspection, product design and marketing. Ice cream acceptability by consumers is mainly perceived by means of texture and flavor. Various ingredients contribute to ice cream's complex colloidal structure and make its perception difficult. In addition, it requires training the judges and proper environmental conditions during assessment. Furthermore, one distinctive characteristic of sensory responses is that they are ambiguous and imprecise; that is, they are fuzzy. Then, by normal statistical analysis of sensory data obtained through subjective evaluation, a complex idea of a product quality is often generated, which makes it nearly impossible to determine the strength and weakness of the product concerning its sensory attributes. Therefore, application of fuzzy set concept could be useful in this area. Combination of fuzzy concept and artificial neural network is of great importance among various combinations of methodologies in soft computing. There are some reports dealing with the sensory evaluation of ice cream based on texture perception. However, there are no or few studies available concerning

the use of computing technology for prediction of consumer acceptance of ice cream. Hence, the objectives of this work were to investigate the efficiency of genetic algorithm-artificial neural network (GA-ANN) and adaptive neuro-fuzzy inference system (ANFIS) simulations for predicting acceptability of hard ice creams during storage. For this purpose, GA-ANN and ANFIS were fed with 4 inputs of flavor, iciness, wateriness and creaminess for prediction of overall acceptability of ice cream. Both models were trained with experimental data. The developed GA-ANN, which included 16 hidden neurons, could predict total acceptance with correlation coefficient of 0.93. The overall agreement between ANFIS predictions and experimental data was also very good ( $r = 0.92$ ). Results of present research showed that both GA-ANN and ANFIS models' predictions agreed well with testing data sets and could be useful for understanding and controlling factors affecting palatability of ice cream.

**Key Words:** ice cream, quality, storage

**T129 Evaluation of textural property changes in three types of low-fat goat milk ice creams during 8 weeks of frozen storage.** Christopher E. McGhee, Brittany I. Davis, Krishna P. Bastola\*, Jolethia O. Jones, and Young W. Park, *Fort Valley State University, Fort Valley, GA.*

Although ice cream is a popular frozen food around the world, low-fat ice creams have problems of low flavor and low textural quality compared with traditional ice creams. Three types of low-fat soft-serve goat milk ice creams were manufactured using whole milk (3.64% fat), 2% fat and skim (0.71% fat) goat milk, and stored at -18°C for 0, 2, 4, 8 weeks to evaluate the effect of extended frozen-storage on textural properties of the caprine products. A commercial cow milk based powdered vanilla flavor pre-mix containing 2.5% fat (Alpha Freeze, Tampa, FL) was formulated into the 3 types of fluid goat milk base for ice cream manufacture, where the final fat contents of the whole, 2% and skim milk mixes were 5.31, 3.84, 1.87%, respectively. Textural characteristics of the ice cream were evaluated using a texture analyzer (TA-XT2 Texture Technologies Corp., Scarsdale, NY). A cylindrical probe, which was made of acrylic material and 2.5 cm in diameter and 3.5 cm in height, was used for detecting shear force (g). The results showed that mean values (g force) of firmness and consistency for freshly made soft serve whole milk, 2% and skim milk goat ice creams were: 208.7, 297.3; 182.8, 261.8; 183.5, 255.0, respectively. There were significant increases ( $P < 0.001$ ) in firmness and consistency of all 3 types of soft-serve low-fat goat ice creams after 1 d frozen-storage. The similar trend of increase was observed in cohesiveness and index of viscosity for all tested products, probably due to the hardening of the texture of the frozen products after 1 d storage. Regardless of fat level of the low-fat caprine milk ice creams, all tested textural properties after 56 d frozen-storage revealed substantial increases ( $P < 0.0001$ ), especially in firmness and consistency traits compared with those of the original soft-serve goat ice creams with extreme high variations. It was concluded that all textural properties of the experimental low-fat goat milk ice creams were very significantly increased after 8 weeks extended frozen-storage.

**Key Words:** goat ice cream, frozen storage, textural property

**T130 Dulce de leche: Characterization by physicochemical and instrumental methods.** Leonardo Gaze<sup>2</sup>, Carlos Conte-Junior<sup>2</sup>, Adriano Cruz<sup>1</sup>, Renata Raices\*<sup>1</sup>, and Monica Freitas<sup>2</sup>, <sup>1</sup>*Federal Institute of Science and Technology of Rio de Janeiro (IFRJ), Rio de Janeiro, Brazil,* <sup>2</sup>*Federal University Fluminense, Rio de Janeiro, Brazil.*

The physicochemical profile of dulce de leche (DL) was determined by both routine analysis and others techniques (HPLC, GC-MS and ICP-OES). Seven Brazilian commercial brands were characterized for moisture content, protein, fat, ash, pH and titratable acidity, mineral content (sodium, potassium, calcium, and phosphorus) and instrumental analysis (carbohydrates content and volatile compounds). Protein, lipid, ash, moisture, lactic acid content and pH ranged respectively from 3.51 to 7.12; 3.56 to 6.99; 1.31 to 2.05; 17.49 to 29.67; 0.23 to 0.50; and 6.14 to 6.37 w/w ( $P < 0.05$ ), with a significant variability in all parameters. Regards the mineral content, it is also reported difference between these parameters was observed for all samples, ranging

from 0.12 to 0.16 g/100 g; 0.28 to 0.40 g/100 g; 0.19 to 0.36 g/100 g; 0.14 to 0.24 g/100 g for sodium, calcium, potassium and phosphorus, respectively ( $P < 0.05$ ). In concordance, a great variation was observed for glucose content, which ranged from 0.09 to 0.75 g/100 g for all the samples, suggesting heterogeneity of the technological processing of DLs. 32 volatile compounds were identified belonging to 10 different chemical families of which only 2 were not present in all samples. In this sense, an increase of intrinsic quality of DL is related closely the standardization of operational parameters using during the manufacture.

**Key Words:** dulce de leche, quality, control quality