

Dairy Foods: Dairy Products I

T239 Evaluation of sensory properties of goat milk ice creams formulated with three different levels of caprine milk fat. C. McGhee, B. P. Gupta*, J. Jones, and Y. W. Park, *Fort Valley State University, Fort Valley, GA*.

Ice cream is a very popular frozen dairy food around the world. Although many studies have been reported on bovine milk ice cream, the scientific literature on caprine milk ice cream has been almost nonexistent. A study was conducted to evaluate sensory characteristics of goat milk ice creams manufactured with 3 fat levels of goat milk and a commercial powdered mix containing 0.25% fat. Three batches of 3 different low fat ice creams were produced as skim (0.46%; SIC), 2.0% (2IC) and whole (3.65%; WIC) goat milk ice creams formulated with the commercial ice cream mix. The Sani Serv ice cream machine (A5223P, Mooresville, IN) was used to make soft-serve ice creams. Upon manufacture, all experimental fresh ice creams were stored in a freezer at -18°C for 0, 2, 4 and 8 weeks. Sensory characteristics of all ice creams were evaluated by an 8-member sensory panel, using ADSA collegiate ice cream scorecards. Flavor traits were determined by normal range of flavor score 1–10, where excellent 10 (no criticism), good 8–9, fair 6–7, and poor 5 or less, respectively. Body and texture, and color properties were assessed by normal range of 1–5 scores, where 5 indicated no criticism. The results showed that there were no significant differences in all sensory characteristics of flavor, body and texture, and color traits between 0 to 8 weeks storage periods for the 3 goat ice creams, except a few cases of flavor and body and texture. No detectable color changes were found in all 3 types of ice creams. For flavor properties, the sweet and whey flavors between 0 and 2–8 weeks for 2IC and WIC were appeared to be different, while no differences in flavors were observed in SIC. For body and texture traits, increases in weak body in WIC, and increases in sandiness and sogginess were occurred in 2IC from 0 to 8 weeks. The 2IC showed a slight improvement in weak body as the storage time advanced. It was concluded that very few changes occurred in sensory properties of all 3 types of goat milk ice creams up to 8 weeks frozen-storage.

Key Words: goat milk, ice cream, sensory property

T241 Influences and mechanisms of heat-related processes during manufacture of milk powder on coagulation quality of milk. X. Han*, L. Zhang, and W. Wang, *Harbin Institute of Technology, College of Food Science and Engineering, Harbin Institute of Technology, Harbin, China*.

Thermal processing during milk powder production changed not only the nutritional characteristics of milk but also its technological characteristics. The purpose of this study is to analyze the effects of the conventional heat sterilization during the manufacture of milk powder on the milk coagulation properties (rennet-induced coagulation and acid-induced coagulation). The texture of rennet-induced gel and acid-induced gel during different heat treatment of milk were analyzed. And the protein distribution of milk serum heat-induced changes in casein micelle size, surface hydrophobic and calcium ion activity were also detected. The results showed the heating parameters have the good regression relationship with the variables of coagulations. The coefficients of determination R^2 were greater than 0.88. The hardness of gel were decreased when heat the raw milk at 70°C for 15 s, while 90°C for 8 min decreased by 37.27% compared with the raw milk. The changes in serum protein aggregates (SPA) were also affected by different heat treatments. The protein aggregates caused by the thermal denaturing of milk protein can be performed as part of the casein micelles in the solidification process, or as a “bridge” between the micelles, thus

contributing to the process of acid curd. However, the protein aggregates did not act such a role in the rennet-induced gel according to the data in the experiment. And the size of SPA increased with the increase of heating temperature and time, ranging from ~ 30 nm at low-intensity heat treatment increased to ~ 100 nm at high-intensity treatment. By the test of rennet coagulation with SPA addition the inhibition effect was not found, suggesting the inhibition of heating on rennet coagulation was not derived from SPA. The rennet coagulation of milk was influenced by the properties of casein micelles and calcium ion. Thus, the combined (positive and negative) effects of heat induced changes of SPA and the properties of casein and calcium ion activity led to the reduced ability of rennet coagulation.

Key Words: milk powder, protein aggregate, rennet gel

T242 Light-protective packaging effectiveness to enhance sensory and nutrient stability of extended shelf life milk and n-3 enriched milk. D. Johnson, S. E. Duncan*, W. N. Eigel, and S. F. O’Keefe, *Virginia Tech, Blacksburg*.

Modification of milk composition with n-3 (omega-3) fatty acids increases risk of product oxidation, which can be accelerated by light. Effectiveness of light protection additives (LPA) incorporated into high density polyethylene (HDPE) packaging in limiting light-induced oxidation of extended shelf-life milk (2% total fat) and n-3 fatty acid enriched milk (2% total fat) was studied. Packaging effectiveness was determined by assessing changes to packaged milk flavor, oxidation, and riboflavin concentration throughout a 35-d shelf life study. Extended shelf-life fluid milk, with and without n-3 fatty acids, was stored in a lighted dairy case (average light intensity: 2200 lx; 4°C). HDPE packaging included no LPA (control; translucent appearance); light-protected (foil overwrap over no LPA control); and 3 LPA levels (low, medium, high) for the experimental treatments. Over the study period, riboflavin concentration in the 2% milk decreased 11% and 29% in the light-protected control and the high LPA packages respectively. Thiobarbituric acid reactive substances assay (TBARS) of more than 1.3 μmol of malondialdehyde (MDA) indicated significant change in flavor; the high LPA package provided effective protection for the 2% milk. In n-3 milk, the high LPA package provided greater protection of sensory quality and riboflavin than the other packages; however, riboflavin decreased by 28% through the 35-d study even in the light-protected control representing a higher loss rate than observed in milk without n-3 lipids. The n-3 milk packaged in the no LPA-HDPE package exceeded MDA of 3.0 μmol by d 7, suggesting the milk would not be of sufficient sensory quality for consumer acceptance. Conversely, the high LPA package protected riboflavin and controlled MDA development most effectively of the LPA packages studied in the n-3 enriched milk beverage. Packaging innovation and design, including light protection material incorporation, can provide improved protection of milk flavor and nutrient content. Product composition influences packaging light protection effectiveness.

Key Words: n-3, packaging, oxidation

T243 Properties of whey protein isolate-maltodextrin conjugates as affected by powder acidity during the Maillard reaction. W. Wang* and Q. Zhong, *The University of Tennessee, Knoxville*.

A challenge of producing shelf-stable high protein ($>4.2\%$ wt/vol) beverages using whey proteins is the protein denaturation and aggregation during heating that result in turbidity and possibly gelation. Our previous studies showed that transparent dispersions of whey protein isolate (WPI) glycosylated

with maltodextrin (MD) were heat stable at pH 3.0–7.0. Glycation was achieved by heating powders spray-dried from a neutral pH solution with equal mass of WPI and MD—the Maillard reaction. However, the undesired brown color and health-concerning advanced Maillard reaction products are to be reduced. In this study, WPI and MD were dissolved at equal mass in water, adjusted to pH 4–7, hereafter referred as “mixture pH – m-pH,” and spray-dried. The obtained powder was incubated at 80°C, 65% relative humidity for 1, 2, and 4 h to prepare conjugates. The resultant conjugates were prepared at 5% (wt/vol) protein in deionized water, adjusted to pH 4–7, hereafter referred as “solution pH – s-pH,” 0–100 mM NaCl and 5% (wt/wt) sucrose. After heating at 138°C for 1 min, the absorbance at 600 (Abs₆₀₀) and 420 nm (Abs₄₂₀) was measured as indicators of turbidity and color formation, respectively. A darker brown color, higher Abs₄₂₀ and lower Abs₆₀₀ were observed for conjugates glycated for a longer time, with all conjugates prepared by 4-h glycation being transparent at all s-pH. For samples glycated for 2 h, a lower m-pH corresponded to a lighter color but was generally less heat stable; the m-pH 6.0 treatment was the most heat stable, with only the pH 5.0 and 0 mM NaCl sample showing turbidity. The m-pH 6.0 treatment corresponded to the highest degree of glycation assessed based on free amino group concentration and the highest denaturation temperature according to differential scanning calorimetry. The transparent samples after heating had mean particle diameters as small as ~13 nm. The combination of m-pH 6 and 2-h glycation was concluded as the most desirable treatment in terms of both heat stability improvement and color reduction. This study suggests that the quality of glycated WPI can be improved by controlling m-pH.

Key Words: whey protein, heat stable, conjugate

T244 Caseinomacropptide index for cheese whey detection in pasteurized milk, Brazil. P. R. Lobato¹, M. E. R. Fortini¹, R. S. Conrado¹, M. M. O. P. Cerqueira^{1,2}, L. M. Fonseca^{*1,2}, M. O. Leite^{1,2}, R. Rodrigues¹, M. R. Souza¹, and C. F. A. M. Penna¹, ¹Department of Food Technology and Inspection, School of Veterinary Medicine, Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, MG, Brazil, ²CNPq, Brasília, DF, Brazil.

Cheese whey is a high nutritive by-product of the cheese industry. However, due to its low commercial value, its use to adulterate milk is a well known and hard to detect in practice. Caseinomacropptide (CMP) index determination by high performance liquid chromatography with gel filtration (HPLC-GF) is officially used in Brazil to investigate whey addition to milk, and it should be no more than 30 mg/L. If CMP index is 30 to 75 mg/L, milk can be used only for specific dairy products, and above 75 mg/L, only for animal feeding. The objective of this study was to evaluate the CMP index method by HPLC-GF to detect fraudulent addition of whey to retail pasteurized milk in Minas Gerais, a state responsible for about 30% of Brazilian milk production. Fifty-six samples of several brands of pasteurized milk were collected from randomly chosen retail stores, and kept under refrigerated conditions until analysis in the Laboratory of Chromatography, School of Veterinary Medicine, Universidade Federal de Minas Gerais, Brazil. CMP index ranged from 30 to 75 mg/L for 1.8%, and above 75mg/L for 30.4% of the samples. Based on CMP index, only 67.9% of the samples were compliant to the standards, with CMP index below 30 mg/L. Fraudulent addition of cheese whey to pasteurized milk was aggravated in some regions with up to 90% of occurrence, and it was brand related. The levels of cheese whey found in pasteurized milk in the current study indicate lower nutrient levels in the final product. It is concluded that quality monitoring in the milk collection must be emphasized and stricter plant inspection is necessary to keep milk integrity in Brazil. Routine

CMP index determination by HPLC-GF might play an important role to monitor cheese whey fraudulent addition to pasteurized milk.

Key Words: food adulteration, CMP index, cheese whey

T245 Milk mineral harvest from dairy streams using filtration technology. L. Mealy*, C. Marella, A. Biswas, and L. Metzger, *Midwest Dairy Foods Research Center, South Dakota State University, Brookings.*

Milk minerals harvested from dairy processing streams have applications in several areas including use as a supplement in a wide variety of food-stuffs. Dairy stream demineralization methods are employed in commercial lactose isolation and can also be used as a pretreatment for other filtration processes to minimize membrane fouling. The objective of this research was to investigate the potential of wide pore ultrafiltration membranes for removal of minerals from skim milk ultrafiltration permeate. Filtration experiments were conducted using a lab scale plate and frame filtration unit. Pre-production water flux rates were obtained at 27°C (80°F). Subsequently, 2000 mL of feed was added to the balance tank and processed at 49°C (120°F) until a 5× volume reduction was achieved. After a rinse of 2000 mL water at 49°C, post-product water flux values were obtained at 27°C. Membrane performance evaluation was based on the flux obtained during the filtration process, percent flux recovery after production and rinsing as well as by mineral retention. In this study, 3 feeds that varied in mineral content (0.91, 0.97 and 1.04%) were standardized to 11.03% total solids and concentrated using [polyethersulfone (PES) membrane with a molecular weight cut off (MWCO) of 20 kDa, and 2 polyvinylidene fluoride (PVDF) membranes with a MWCO of 30 and 40 kDa, respectively]. Significant differences in both product flux values and ash recovery were seen between feed - membrane pairs analyzed. The PVDF membrane with MWCO 40 kDa exhibited the highest product flux rate of 117 LMH and ash retention of 41%. Future work will focus on using these membranes for industrial scale applications.

Key Words: milk mineral, ultrafiltration

T246 Characterization of whey protein films incorporated with oregano essential oil (*Origanum vulgare*). S. P. L. F. de Oliveira¹, I. M. B. Dianin¹, A. P. Bilck¹, C. M. V. B. de Rensis¹, L. C. Bertan², and P. C. B. Vianna^{*1}, ¹Universidade Norte do Paraná (UNOPAR), Londrina/PR/Brazil, ²Universidade Federal da Fronteira Sul (UFFS), Laranjeiras do Sul/PR/Brazil.

The aim of this study was to evaluate the characteristics properties (visual appearance, thickness, water vapor permeability and water solubility) of the whey protein films incorporated with oregano essential oil. The films were produced by casting technique from whey protein isolate and added of oregano oil at 4 concentrations: 0% (control film), 0.5%, 1.0% and 1.5% (vol/vol). The whey protein isolate was dispersed in distilled water, added with glycerol (3%) and heated at 90°C/30 min in water bath. The oregano oil was added to the solutions before heating. The film solution was spread on Petri dishes (90 cm of diameter) and dried for 24 h at room temperature. The films were removed from the plates with a spatula and stored at controlled humidity (52%) at 25°C/48 h before analysis. The results were evaluated by ANOVA and Tukey's test at 5% significance level. Generally, films presented transparent and homogeneous, with a slight yellow color. The films were more flexible with increasing oregano oil concentration. The films thickness ranged from 0.013 mm to 0.015 mm, and the control film showed significantly thinner than the films added with 0.5 and 1.0% of oregano oil. The water vapor permeability decreased significantly in added oregano oil films when compared with control film. However, increasing the concentration of oregano oil caused no significant changes in water vapor

permeability. The solubility ranged from 14.0% to 20.2%, with the control film significantly more soluble than 1.5% added oregano oil. Probably the hydrophobic characteristic of oregano oil influenced the decrease in water vapor permeability and solubility of the films suffered its addition. The results indicate that whey protein isolate is a good matrix for production of biodegradable films and addition of oregano essential oil, even in small quantities positively affected the characteristics of the films. The oregano essential oil can also confer antimicrobial properties for these films.

Key Words: whey protein, film, oregano oil

T247 Effect of Sicilian pasture feeding management on content of α -tocopherol and β -carotene in cow milk. V. M. Marino^{*1}, I. Schadt¹, S. Carpino¹, M. Caccamo¹, S. La Terra¹, C. Guardiano¹, and G. Licitra^{1,2}, ¹CoRFiLaC, Ragusa, Italy, ²DISPA, Catania, Italy.

This study was performed to evaluate α -tocopherol and β -carotene content of pasture milk under ordinary Sicilian farming conditions. Fourteen dairy farms were allocated into 2 balanced groups on the basis of cultivated (CULT) and spontaneous (SPO) pasture type feeding. Bulk milk per farm was collected 4 times from February through April with 3-wk intervals. Pasture botanical and diet composition, diet nutritional quality, milk yield and composition were estimated each time. Pasture intake levels were calculated based on feed analyses and hay and concentrate amounts fed and, on milk yield and chemical composition using CPM Dairy. In accordance to pasture intake the farms were split into a low pasture (LPI; < 29.5% DMI) and a high pasture intake group (HPI; > 29.5% DMI). Milk samples per farm were analyzed for α -tocopherol and β -carotene contents. Spontaneous milk had higher levels ($P < 0.05$) of α -tocopherol and β -carotene in milk (0.7 and 0.3 mg/L, respectively) and in milk fat (19.0 and 7.5 mg/kg fat, respectively) compared with CULT (0.5 and 0.2 mg/L milk; 14.6 and 4.9 mg/kg fat, respectively). High pasture intake compared with LPI increased α -tocopherol in milk fat (18.0 and 16.0 mg/kg fat, respectively; $P < 0.05$). However, only in SPO but not in CULT milk, HPI increased α -tocopherol ($P < 0.05$) and β -carotene ($P < 0.01$) in milk and β -carotene in milk fat ($P < 0.05$) (0.8, 0.3 mg/L milk and 8.4 mg/kg milk fat, respectively) compared with LPI (0.6, 0.2 mg/L milk and, 6.6 mg/kg milk fat, respectively). All results may be explained by the different botanical composition of both pasture types. Spontaneous pasture compared with CULT contained more Asteraceae, Fabaceae, Cruciferae, Euphorbiaceae and Malvaceae. Milk and milk fat α -tocopherol levels were higher at the test-d 1, 2 and 4 compared with 3 ($P < 0.01$). At HPI milk fat β -carotene content was higher at the

first 2 test-days compared with the others ($P < 0.05$). These differences are probably related to plants' biological stage. On Sicilian dairy farms highest milk α -tocopherol and β -carotene content may be obtained feeding SPO pasture at high levels.

Key Words: milk, fat-soluble vitamin, pasture

T249 Whey permeate used as salt substitute in processed foods. S. Chizonda*, E. M. Dixon, Y. Jiang, and J. C. Allen, North Carolina State University, Raleigh.

Whey permeate (WP) from ultra-filtration of whey and milk is considered a low-priced by-product in cheese and whey protein production. WP contains lactose (80–89%) fat, moisture, soluble non-protein nitrogen and minerals. WP minerals help provide salty taste even if Na content is low. The objectives of this study were to utilize WP as a salt substitute to decrease Na and Cl content and increase K, Ca, and Mg content in several food products. People who consume significant quantities of such products might decrease hypertension risk. Furthermore, with increasing demand for cheese and whey protein, there will be more WP available and a need to find new ways to utilize it. Powdered WP was analyzed with ICP for 7 minerals (Na, K, Ca, Mg, Fe, Zn, Cl). The saltiness intensity of WP and NaCl in aqueous solution were determined by a trained descriptive panel ($n = 12$) to calculate the equivalent concentrations of salt and permeate for salty taste. WP was used as a salt substitute based on the salty taste equivalencies in reformulating canned cream soup base, fresh cream soup base, smoked sausage, and bread. Consumer panels evaluated the products. Fresh WP soup was ranked in salty taste slightly lower and canned soup slightly higher than soup with 50% of salt omitted. However, the fresh and retorted soup formulations made from permeate actually contained only 11% and 19% as much Na as the full-salt recipe, respectively. Sausages made with 25% WP salt substitution were not different than the 100% salt sausage in overall liking, flavor, saltiness, texture, firmness, juiciness or deformability ($P < 0.05$). WP sausages had lower water activity and pH than the 100% salt sausage, and lower ingredient cost. The foods made with WP were lower in Na and Cl and had higher K, Ca, and Mg levels. The WP foods had higher saltiness than the actual sodium content's contribution to the taste, but not as high as predicted from the salty taste of the permeate in aqueous solution, suggesting mineral interaction with other food ingredients. This research showed the feasibility of using WP as a salt substitute in several processed food products.

Key Words: whey permeate, sodium reduction, processed food