### Dairy Foods: Products

**M113** Flavor compounds and quality parameter changes during refrigerated storage of goat milk butter. J. H. Lee¹, A. Discua²,¹, and B. B. Lemma¹, ¹Fort Valley State University, Fort Valley, GA, ²FreshDirect Co., New York, NY.

Because of its nutritional and health benefits, goat milk products have been attractive to health-conscious consumers. While use of goat milk in cheese and yogurt making is well known, its use for butter has been limited. Furthermore, there is limited information available for volatile compounds in goat’s milk butter. The aim of this study was to evaluate the volatile compounds and quality parameters of goat milk butter stored under refrigerated condition. Nine different batches of goat milk butter were produced by continuous churn of cream from goat milk at the university creamery. Each batch of butter was divided into 4 portions. Each portion was subdivided into 4 samples, stored in closed plastic containers at 5°C for 0, 1, 3, 6 mo. Color (CIE, L*a*b*), texture, and peroxide value (PV) were measured from each samples. Fatty acid profiles and volatile compounds of butter samples were analyzed using methylation with gas chromatography (GC) and solid phase microextraction (SPME) with GC-mass spectrometry (MS), respectively. The properties of color and texture of butter were not affected by storage time. After 6 mo, PV significantly increased (P < 0.05) from 1.21 to 3.03 (meq peroxide/kg fat). Among 18 isolated fatty acids, the relative weight percentages of caproic (C6:0), caprylic (C8:0), capric (C10:0) acids significantly increased (P < 0.05), whereas the percentage of palmitic (C16:0) acid decreased (P < 0.05) after 6 mo of storage. Of 35 identified volatiles, butanoic acid, hexanoic acid, δ-valerolactone, δ-decalactone, limonene, and toluene were the most intensive volatile compounds in goat milk butter, whereas these compounds did not changed during storage. Results indicated that the lipid oxidation of goat milk butter was increased over a 6-mo refrigerated storage period. However, the increment of lipid oxidation in butter was not revealed in its volatile compounds.

**Key Words:** goat milk butter, solid-phase microextraction (SPME), volatile compound

**M114** Effects of polymerized whey protein prepared directly from cheese whey as fat replacer on physiochemical, texture, microstructure, and sensory properties of low-fat set yogurt. T. Fang¹, C. Wang¹,³, J. Hou¹, and M. Guo², ¹Department of Food Science, College of Food Science and Engineering, Jilin University, Changchun, Jilin Province, China, ²Department of Food Science, Northeast Agriculture University, Harbin, Heilongjiang Province, China, ³Department of Nutrition and Food Sciences, College of Agriculture and Life Sciences, University of Vermont, Burlington, VT.

Polymerized whey protein has been used for yogurt making. The aim of this study was to investigate the effects of polymerized whey protein prepared directly from cheese whey on physiochemical, texture, microstructure and sensory properties of low-fat set yogurt. Cheddar cheese whey was pasteurized (60°C for 30 min) and pre-filtered using screen mesh. The treated whey was subjected to microfiltration (MF, 0.1 μm, at 50°C for 1 h). MF whey was ultrafiltrated (UF) using a 10 kDa cut-off membrane to 25-folds. The UF treated whey was electro-dialyzed (ED) to remove 90% of salt and the final protein content of the concentrated whey protein was ~10.0%. The majority (~72%) of particle size distribution of polymerized whey protein (70°C for 10 min, pH 7.0) prepared directly from whey was in the range of 1–3 μm. The PWP (1.4% protein, wt/wt) was added to skim milk as a fat replacer to make low-fat set yogurt. Samples were evaluated on sensory properties, texture, and apparent viscosity in comparison with full-fat (3.0% fat, wt/wt), low-fat (1.0% fat, wt/wt) and nonfat (0% fat, wt/wt) milk yogurt. The viscosity of low-fat yogurt incorporated with PWP (1787.98 ± 37.14 mPas) was significantly higher than low-fat yogurt (1678.76 ± 66.27 mPas), but no statistically significant difference with full fat yogurt (1826.01 ± 69.86 mPas). The firmness of yogurts with PWP were significantly higher (P < 0.05) than the control yogurts without PWP separately. All yogurt samples were assessed for sensory attributes using principal component analysis. The first component explained 52.3% of total variability and was mainly related to the sensory indicators caused by cheese whey and texture attributes. And low-fat yogurt with PWP had better flavor properties among all samples. In conclusion, PWP prepared directly from whey through membrane separation technology can be used as a fat replacer to develop low-fat yogurt with desired characteristics. The polymerized whey protein (PWP) could be used as a natural and economical ingredient for formulation of low fat milk based fermented foods.

**Key Words:** polymerized whey protein, whey, low-fat yogurt

**M115** Engineering innovative dairy emulsion droplets to mimic native milk fat globules. H. Zheng,¹ L. Ingram², J. A. Ortiz Salazar³, J. Lu³, and R. Fernando¹, ¹Dairy Innovation Institute, Department of Animal Science, California Polytechnic State University, San Luis Obispo, CA, ²Department of Biomedical Engineering, California Polytechnic State University, San Luis Obispo, CA, ³Department of Chemistry and Biochemistry, California Polytechnic State University, San Luis Obispo, CA, 4Dairy Processing group, Institute of Food Science and Technology, Chinese Academy of Agricultural Science, Beijing, China.

The impact of milk fat globule membrane (MFGM)-coated emulsion droplets on lipid digestion has become an interesting research topic. Efficiently manufacturing emulsion droplets coated by MFGM materials has been a technological challenge. The MFGM materials are enriched in buttermilk, and they may be further concentrated in buttermilk concentrate (BMC) using membrane filtration technology. In the current research, the emulsification capacity of in-house manufactured BMC was investigated. Response surface methodology (RSM) was used for optimizing the volumes and ratio between BMC as the emulsifier and milk fat as the oil phase, 1–15% of BMC (variable 1) and 1–15% anhydrous milk fat (AMF, variable 2) were combined at different ratios for manufacturing emulsion systems. Emulsions were manufactured by using homogenizer at 100MPa with 5 passages. All emulsions were heat-treated at 70°C for 30min for testing the physical stability after pasteurization. Both protein and fat contents are enriched in BMC comparing with original dried buttermilk (DBM) (P < 0.05). The lipodomics results showed that phosphatidylcholine is about 14% enriched in BMC powder comparing with original DBM. A 6-mo shelf life study showed that BMC is an efficient emulsifier. Particle size distribution (PSD) results showed that an emulsion system made from 8% BMC + 8% AMF (namely 8/8-BMC emulsion) had D4,3 as 3.9 ± 0.14 μm. Moreover, the sample PSD profile is similar to the PSD profile of raw milk. Confocal laser scanning microscopy images confirmed that both protein and MFGM phospholipids were loaded onto the surface of BMC stabilized emulsion droplets. Using amplitude sweep technique, the rheological characterization confirmed that the 8/8-BMC emulsion was in liquid state at both 5°C and 25°C (loss tangent >1). Stress ramp
M116  Effect of cavitation and nanofiltration temperature on the functionality of MPC80. A. Mishra* and L. Metzger, South Dakota State University, Brookings, SD.

Nanofiltration (NF) is typically utilized during MPC manufacture to concentrate ultrafiltration retentate before drying. In related research we determined that increasing the NF temperature from 22°C to 50°C and use of hydrodynamic cavitation (HC) improved nanofiltration performance and increased the level of total solids that can be achieved. In this study 3 replicates of 4 different NF retentates were spray dried and the functionality of the dried MPC was evaluated. The NF treatments utilized were: NF at 22°C (NF22); NF at 50°C (NF50); HC before NF at 22°C (HCNF22); and HC before NF at 50°C (HCNF50). All samples were spray dried using a pilot scale dryer (Niro dryer Model 1, Niro Inc., Columbia) using air atomizing-flat spray nozzle (SUE15A, external mix) with an inlet and outlet temperature 170°C and 85°C respectively. The powders produced were analyzed for physicochemical and functional quality. The moisture content of all powders was below 5% and the protein and ash content ranged from 79.81 to 81.29% and 7.23–7.35% respectively. The loose bulk density was 353, 332, 358, and 323 Kg/m³ and the tapped bulk density was 454, 428, 456, and 421Kg/m³ respectively for the NF22, NF50, HCNF22, and HCNF50 treatments. The loose and tapped bulk density was significantly (P < 0.05) higher in treatments NF at 22°C, whereas HC did not have a significant (P > 0.05) impact on loose or tapped bulk density. There were no significant differences in solubility at 22°C or 50°C or wetting time at 22°C; however, HC significantly (P < 0.05) decreased the wetting time at 50°C. There were no significant (P > 0.05) differences in emulsification capacity, emulsion stability, or foam stability, whereas foam capacity was significantly higher in the treatments that were nanofiltered at 50°C. The rennet coagulation time significantly (P < 0.05) increased and the heat coagulation time significantly (P < 0.05) decreased in the treatments that were nanofiltered at 50°C. This study determined that NF temperature and HC have important effects on the functionality of dried MPC80 and can be utilized to adjust the functional characteristics of MPC80.

Key Words: MPC80, hydrodynamic cavitation, nanofiltration

M118  Sensory evaluation and intent-to-purchase of milk yogurts mixed with milk from other species. R. D. S. Gomes1, A. F. S. Gomes1, I. L. S. Oliveira1, E. G. S. O. Silva1, H. A. P. Lopes1, I. M. Barbosa1, D. C. Sales2, L. H. F. Borba1, M. F. Bezerra3, J. G. B. Galvão Jr.2, and A. H. N. Rangel*1, 1Universidade Federal do Rio Grande do Norte, Maceió, RN, Brazil, 2Instituto Federal de Educação do Rio Grande do Norte, Ipanguaçu, RN, Brazil, 3Universidade do Estado de São Paulo, Jaboticabal, SP, Brazil.

The objective of this study was to evaluate the sensory acceptance and the intent-to-purchase of 3 yogurt formulations made with 50% donkey’s milk in a mixture with bovine (DBV), buffalo (DBF) and goat’s milk (DGO) supplemented with sugar (8%) and concentrated mango pulp (15%). The attributes of appearance, aroma, flavor and consistency of the yogurts were evaluated by 95 untrained tasters on the third and first day of shelf life by applying the 9-point hedonic scale test anchored at extremes of 1 (I highly disliked it) and 9 (I liked it very much). We also used a scale ranging from 1 (would not buy) to 5 (would buy) to evaluate intent-to-purchase. The data were submitted to variance analysis and the means were compared by Tukey test at 5% significance by the SAS program (version 9.0). The results showed that on the third day of storage, the DBV and DBF formulations were similar (P > 0.05) in all evaluated attributes and in the intent-to-purchase, and also presented higher mean values (P < 0.05) than the DGO formulation for consistency and purchase intent. On the first day of shelf life, the DBF formulation reached the highest averages (P < 0.05) for taste and purchase intent. Appearance and aroma were similar for all formulations during the 31 d of storage, with sensory scores between “slightly liked” (6.0) and “liked regularly” (7.0). The formulation with donkey and goat milk had lower mean values for the consistency attribute when compared with the others (P < 0.05). In relation to the flavor, the DGO formulation values were similar (P > 0.05) to the DBV on the third day of shelf life and to the DBF on the first day, in spite of presenting lower mean values. The lower means achieved by the DGO yogurt were probably influenced by the more fluid consistency of this formulation provided by the presence of goat milk. The results show that donkey milk yogurts added with bovine, buffalo and goat’s milk reached good sensory acceptance up to 31 d of storage.

Key Words: sensory analysis, donkey, shelf life
M119  Influence of β-galactosidase and temperature treatment to milk on functional and reconstitution properties of low-lactose milk powders by spray drying. S. Ditudombo*, J. Peepanich, S. Jarnpim, T. Kunanopparat, and S. Rungchang, 1Faculty of Agricultural Product Innovation and Technology, Srinakharinwirot University, Nakhon Nayok, Thailand, 2Department of Food Engineering, King Mongkut’s University of Technology Thonburi, Bangkok, Thailand, 3Department of Agro-Industry, Naresuan University, Phitsanulok, Thailand.

The aim of this study was to determine effects of β-galactosidase and temperature treatments to milk on functional and reconstitution properties of low-lactose milk powders (lactose <0.1%). Skim milk mixed with 5000 NTU/L of β-galactosidase were incubated at 4, 35 and 50°C, which was stirred for 1 h and then stored under refrigeration at 4°C for 20 h before spray drying at the inlet and outlet air temperatures of 170/85°C. Hydrolyzed lactose milk powder (HLMP) was darker than unhydrolyzed lactose milk powder (control) because of the greater amount of reducing sugars, which causes the Maillard reaction. HLMP had higher redness (a*) value and lower water activity compared with the control (P < 0.05). HLMP had no significant effect on lightness (L*) and yellowness (b*) values, moisture content and bulk density. In addition, HLMP led to a reduction in wettability and dispersibility, which means that HLMP is difficult in rehydration (P < 0.05). As the incubation temperature increased, the rate of glucose released also increased. Bulk density was increased and wettability and dispersibility were decreased with increase in the incubation temperature (P < 0.05). Incubation temperature had no significant effect on color, moisture content and water activity of HLMP. According to Carr’s index and Hausner ratio values, the flowability of the control and HLMP incubated at 4°C were “poor,” while HLMP incubated at 35 and 50°C were “very poor.” The results revealed that the increase in the rate of lactose hydrolysis resulted in a larger agglomeration of particles. This could explain the decrease in the rehydration capacity of the powders.

Table 1 (Abstr. M119). Functional and reconstitution properties of low-lactose milk powders incubated at different temperatures (4°C, 35°C, and 50°C)

<table>
<thead>
<tr>
<th></th>
<th>Untreated</th>
<th>β-galactosidase</th>
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<tr>
<td></td>
<td>4°C</td>
<td>35°C</td>
<td>50°C</td>
<td>50°C</td>
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<tr>
<td>Water activity</td>
<td>0.26±0.02</td>
<td>0.21±0.01</td>
<td>0.21±0.01</td>
<td>0.23±0.02</td>
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<tr>
<td>L* Ns</td>
<td>91.38±74.7</td>
<td>91.15±74.4</td>
<td>90.66±74.4</td>
<td>91.04±7.44</td>
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<tr>
<td>a* Ns</td>
<td>−1.12±0.10</td>
<td>−0.51±0.05</td>
<td>−0.59±0.06</td>
<td>−0.64±0.07</td>
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<tr>
<td>b* Ns</td>
<td>7.21±0.61</td>
<td>7.78±0.65</td>
<td>7.60±0.64</td>
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<tr>
<td>Wettability (s)</td>
<td>175.3±11.3</td>
<td>136.0±10.3</td>
<td>43.3±3.7</td>
<td>44.4±2.6</td>
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<td>Dispersibility (%)</td>
<td>202.9±23.5</td>
<td>135.0±11.0</td>
<td>120.0±9.8</td>
<td>97.1±6.4</td>
</tr>
</tbody>
</table>

*Means within a row with different superscripts are significantly different (P < 0.05).

Key Words: β-galactosidase, low-lactose milk powder, spray drying

M120  Use of polymerized whey protein as a gelation agent for symbiotic almond yogurt formulation. H. Shi*, X. Zhang, and M. Guo, 1University of Vermont, Burlington, VT, 2Northeast Agricultural University, Harbin, Heilongjiang, China.

Almond milk-based products are becoming increasingly popular as milk product alternatives. In this study, a symbiotic almond yogurt containing probiotics and inulin as a prebiotic was developed using polymerized whey protein (PWP) as a gelling agent. PWP was prepared by heating 10% (wt/vol protein) of whey protein isolate solution at 85°C for 30 min at pH 7.0. The samples fortified with 0.6% PWP, 0.3% pectin and 0.07% xanthan gum have good consistency and mouth feel. The physiochemical properties of this symbiotic almond yogurt like product were analyzed for total solids 16.87 ± 0.04, protein 2.71 ± 0.17, fat 3.97 ± 0.19, carbohydrates 9.88 ± 0.08, and ash 0.26 ± 0.03 g/100g. The pH of this product was 4.47 ± 0.01 and the viscosity was 11.91 ± 2.27 mPa·s. The initial populations of the major probiotics in the samples were about 10^8 cfu/mL. The symbiotic almond set yogurt is not only a good source of protein and relatively low fat compared with a commercial sample, but has smooth texture and a refreshing taste. The results indicated that PWP may be a suitable gelation agent for formulating non-dairy fermented products. Future studies are being conducted on shelf-life tests and probiotic survivability during 10-week storage.

Key Words: whey protein, almond, yogurt