Dairy Foods: Cheese

M70  Comparison of different types of acidity values of three phases of caprine cheese milk during Cheddar cheese manufacture. R. Paswan*, A. Siddique, and Y.W. Park, Fort Valley State University, Fort Valley, GA.

There are several methods of measuring acidity of milk, including titratable acidity (TA), Soxhlet-Henkel (SH) value, acidity Dornic (AD) and acidity Therat (AT) values. TA is a measurement of any constituent that will react with or neutralize the 0.1 N sodium hydroxide. Fresh milk practically contains no lactic acid (LA), but still require an amount of NaOH to reach the phenolphthalein endpoint. During cheese making process, the cheese milk undergoes a variety of physicochemical changes. The objective of this study was to compare the differences in levels of LA, SH, AD and AT for 3 different stages of caprine cheese milk, such as fresh pasteurized milk (FPM), culture ripened milk (CRM) and whey milk (WM) during the entire procedure of Cheddar cheese manufacture. Three batches of fresh raw caprine milk were collected from the bulk tank of the Georgia Small Ruminant Research and Extension Center, Fort Valley State University, Fort Valley, GA, and pasteurized at 63°C for 30 min, cooled to 31°C, and then goat Cheddar cheeses were processed. The experimental cheese milk samples were taken at 3 different stages of cheese manufacture. The physicochemical parameters of acidity values were determined using a MilkoScan FT1, which is FTIR (Fourier Transform Infrared Spectroscopy) interferometer. The precision and stability of MilkoScan FT1 were calibrated by traditional AOAC approved fixed filter, which relies on every sine function being defined by its frequency (wavelength) and its amplitude (intensity) of IR beam. The results showed that LA, SH, AD and AT values for the FPM, CRM and WM stages were: 0.11, 0.17, 0.13; 5.34, 7.87, 5.85; 11.81, 17.83, 13.31; 12.86, 19.14, 14.71, respectively. All tested acidity values revealed that CRM samples were highest, followed by WM and FPM samples, indicating that the CRM samples cultured for one hour with Chymax starter contained significantly higher lactic acid levels generated by the starter culture bacteria. All tested acidity parameters showed the same trend of increased acidity in CRM compared with FPM and WM samples. It was concluded that the 4 tested acidity indicators of CRM had the highest values among the 3 phases of the caprine cheese milk.

Key Words: goat milk, cheese milk, acidity values

M71  Fatty acid profiles of control and iron-fortified caprine milk Cheddar cheeses stored under different time and temperature. A. Siddique* and Y.W. Park, Fort Valley State University, Fort Valley, GA.

Nutritional quality of a dietary fat is greatly influenced by fatty acid composition of a specific food. Caprine milk is known to have significantly high amounts of short chain and medium chain fatty acids (MCT). The objective of this study was to compare fatty acid compositions of non-fortified control (NC) with those of 2 types of iron fortified [regular ferrous sulfate (RFS) and large microencapsulated ferrous sulfate (LMFS) salts added] caprine Cheddar cheeses stored under different storage times and temperatures. Three batches of NC, RFS and LMFS cheeses were manufactured using the goat milk taken from the bulk tank of the Georgia Small Ruminant Research and Extension Center, Fort Valley State University, Fort Valley, GA. Iron was fortified for RFS and LMFS cheeses by addition of 8.23g and 9.03g Fe per 9 kg cheese, respectively at milling step, formulating 16% Fe in both forms of ferrous sulfate. Each batch of the cheeses were subdivided into 3 groups, packaged in 2”x3” plastic pouches, and stored for 0, 2 and 4 mo at 4 and −18°C. Results showed that palmitic acid (C16:0) content was the highest in all treated cheeses, followed by C18:1, C18:0, C14:0, C10:0, C8:0, C12:0 and C18:2 acids. The lauric/capric acid (C12:10) ratio was 0.40, which is unique to caprine milk and lower than that of bovine counterpart. Significant (P<0.05 or P<0.01) differences were found between cheese types and between storage periods in levels of all tested fatty acids except C16:1, C20:0 and C24:0 acids. Fatty acid contents of RFS and LMFS cheeses tended to be higher at longer storage time (4 mon) than those of initial NC samples. The 2-way interactions of cheese type x storage period, cheese type x storage period and storage period x temperature had significant (P<0.05 or P<0.001) effects on C10:0, C12:0; C6:0, C8:0, C18:2; and C4:0, C6:0, and C14:0 concentration, respectively. Storage temperature showed significant effect on C10, C12, C14, C14:1 and C18:1 levels. It was concluded that iron fortification and longer storage periods had significant effects on fatty acid levels than those of fresh control caprine milk Cheddar cheese samples.

Key Words: fatty acid content, iron fortification, storage

M72  Physicochemical, textural and sensory characteristics of control and rice powder-added Camembert cheeses during 4 weeks of aging. J. H. Nam1, H. C. Bae1, Y. W. Park*2, and M. S. Nam1,1 Chungnam National University, Daejeon, Chungnam, Korea, 2Fort Valley State University, Fort Valley, GA.

Camembert cheese (CC) is a moist, soft, creamy, surface-ripened cheese, originally made from unpasteurized cow milk in Camembert, Normandy of northern France. The surface of CC is sprayed with mold Penicillium camemberti, and ripened for minimum 3 weeks for its characteristic flavor. The objectives of this study were to compare physicochemical, rheological and sensory characteristics of rice powder added Camembert (RPAC) cheeses with those of non-supplemented control Camembert (NSCC) cheese during 4 weeks aging. NSCC and 3 levels (1, 3, 5%) RPAC cheeses were manufactured and evaluated for viable cell counts, and physicochemical, rheological and sensory properties of all experimental cheeses during 4 wk of ripening. Results showed that viable lactobacillus bacteria (LAB) counts after 4 wk of ripening in NSCC, 1, 3 and 5% RPAC cheeses were: 1.0 × 10^8 ± 0.12, 1.3 × 10^8 ± 0.26, 1.02 × 10^9 ± 0.15 and 1.02 × 10^9 ± 0.17 cfu/mL, respectively, indicating that 1% RPAC cheese had the highest viable LAB counts among all RPAC and NSCC cheeses. The level of water-soluble nitrogen was also the highest (115.69 μg/g) in 1% RPAC cheese among all cheese groups at 4 weeks aging. Isocitric acid, lactic acid, propionic acid, butyric acid, lactose, glucose and galactose in all cheese treatment groups were decreased as ripening period advanced. Protein degradation was most actively occurred in low molecular weight peptide at 2 weeks ripening in all RPAC and NSCC cheeses. The 1% RPAC cheese contained the lowest unpleasant flavor components, such as goaty, soapy, waxy, musty, rancid, and sour flavors. For the perspective of rheological characteristics, hardness (g) at 2–4 wk ripening was the lowest in 1% RPAC cheese compared with 2 other treated groups and NSCC. However, there were some variations in springiness, cohesiveness, gumminess and chewiness traits among different cheese groups. Sensory scores revealed that the 1% RPAC group showed the mildest taste, where its overall acceptability score was 4.10 ± 1.48. It was concluded that the 1% rice RPAC cheese displayed highest (P<0.05) viable cell counts.
and favorable physicochemical, textural and sensory properties among all tested experimental CC cheeses.

**Key Words:** Camembert cheese, rice powder, physicochemical properties

### M73 Effect of storage of high concentrated micellar casein on the functional properties of process cheese. A. R. A. Hammann*, S. L. Beckman, V. Sunkesula, and L. E. Metzger, *Dairy and Food Science Department, South Dakota State University, Brookings, SD.*

Micellar casein is a relatively new dairy protein concentrate that can be used in process cheese products (PCP). PCP is a dairy food prepared by blending and heating various dairy and non-dairy ingredients to produce a pasteurized product with an extended shelf life. The objective of this study was to utilize highly concentrated micellar casein (HC-MC) as an ingredient in PCP and examine the effect of storage (0, 30, and 60 d at 4°C) of HC-MC on functionality of PCP. PCP formulations were prepared by mixing all ingredients (aged Cheddar cheese, HC-MC, water, unsalted butter, deproteinized whey, sodium phosphate dibasic, salt, and sodium citrate) in a kitchenaid at room temperature for 30–40 min to produce a homogeneous paste. A 25g sample of the mixture was weighed in a canister (5 replicates) and tempered at 38°C for 15–20 min and then cooked in the rapid visco analyzer (RVA) for 4 min at 90°C. The stirring speed was 1000 rpm during the first 2 min of the test and was then reduced to 160 rpm during the final 2 min. Once the PC was cooked, it was poured in molds and stored at 4°C for further analysis. This experiment was repeated 3 times using 3 different batches of HC-MC at each time point of storage (0, 30, and 60 d). The functionality of the PCP was measured by determining the cooked viscosity, texture profile analysis (TPA) hardness, and dynamic stress rheometry (DSR) melt temperature. The moisture content and pH of the PCP was not affected (P > 0.05) by storage of the HC-MC and ranged from 47.1 to 48.1% and 5.70–5.71, respectively. The cooked viscosity of the PCP was not affected (P > 0.05) by storage of the HC-MC and ranged from 755 to 769cP. However, there was a small but significant (P < 0.05) decrease in TPA hardness (135 to 105g) and DSR melt temperature (58.4 to 56.4°C) with HC-MC storage. This study demonstrates that HC-MC can be utilized in PCP formulations and small but significant changes in functionality were observed when the HC-MC was stored at 4°C for 60 d.

**Key Words:** process cheese product, micellar casein, shelf life

### M74 Effect of delactose permeate fraction addition and direct acidification on low moisture part skim mozzarella composition. D. Grossbier* and T. Schoenfuss, *University of Minnesota, St Paul, MN.*

The dairy industry is interested in finding value-added uses for low value co-products of cheese manufacturing. Nanofiltered delactose permeate (DLPF) is one such product where lactose is further reduced from delactose cheese permeate, leaving higher milk mineral concentrations. The objective of this study was to evaluate the effect of this ingredient on the composition of direct-acidified low moisture part-skim mozzarella (LMPS). LMPS was produced in duplicate (~3 mo apart) by direct acidification using lactic, acetic, and citric acids at pH 5.6 and 5.4. Each batch was equally split and dry salted to achieve a salt equivalent of 1.8 (control) and 1.2% (reduced sodium). An additional split was made of the reduced sodium LMPS to which DLPF was incorporated as a hot brine during plasticization. Gross compositional analyses including: solids, fat, and ash were performed in duplicate. Multivariate Analysis of Variance using XLSTAT (Addinsoft Inc., New York, NY) was performed. Overall, DLPF treatments had lower solids and fat. Control treatments were significantly higher in ash (3.04%) than reduced sodium (2.34%) and the DLPF treatments (2.34%). With the exception of the lactic and acetic acid treatments at pH 5.6, all other DLPF treatments had significantly lower solids than non-DLPF treatments. When LMPS was manufactured using lactic or citric acid, DLPF incorporation resulted in significantly lower fat contents of the cheese. However, DLPF treatment did not affect fat contents when acetic acid was used as acidulant. Furthermore, when assessing fat on a solids basis, no differences were seen with both the acetic and lactic acid DLPF treatments and all non-DLPF treatments. Maintaining fat retention and adequate moisture is critical for profitability. The use of DLPF in acidic direct acidification was found to increase moisture retention while not affecting fat content. Further research should focus on effects of DLPF on LMPS sensory and functionality.

**Key Words:** mozzarella, cheese, permeate

### M75 Effect of basil (Ocimum basilicum Lamiaceae) on technological properties of buffalo fresh cheeses. B. R. Saraiva 1, B. C. Agustinho2, J. C. R. Ribas2, A. C. P. Vital2, L. Zeoula2, and P. T. Matumoto-Pinto1,2, *1Programa de Pós-Graduação em Ciência de Alimentos, Universidade Estadual de Maringá, Maringá, Paraná, Brazil, 2Programa de Pós-Graduação em Zootecnia, Universidade Estadual de Maringá, Maringá, Paraná, Brazil.*

The objective of this study was to evaluate the effect of basil (BA) addition, on the technological properties (texture profile and structure) of fresh cheese (FC) prepared with pasteurized buffalo milk during 21 d of storage at 4°C. Different concentrations of basil were added for FC production: 0.0% (Control without basil, CON), 0.25% (BA0.25), 0.50% (BA0.5) and 0.75% (BA0.75) of basil. These concentrations of BA were determined by previous trials. For production of control treatment (CON), the milk was heated to 35°C, calcium chloride (1g/L milk), and chymosin (0.04 g/40L) were added. Solution was rested for 45 min at 35°C to coagulation. The cheeses mass was cut, molded, and remained for 60 min at 4°C for whey expulsion before vacuum packed, the vacuum process was 15 s for not alter the cheese structure. For production with BA, it was added in the milk and homogenized (15 min) before the heating step (35°C) to coagulation. During the storage period, the FC was analyzed for hardness (g), chewiness (mL), and cohesiveness by Brookfield Texture Analyzer CT-III with an acrylic circular probe (diameter 38.1mm and height 20mm); and the Scanning Electron Microscopy (SEM) was also realized after samples were frozen with liquid nitrogen and lyophilized. The hardness increased for FC with BA (P < 0.05) throughout of storage, and BA0.75 presented the higher values. The chewiness was higher (P < 0.05) with 15 and 21 d of storage for all treatments. The cohesiveness not present difference during the storage and between treatments. Results with scanning electron microscopy (SEM) images showed that BA altered the structure of FC. With BA addition, FC presented smaller voids spaces and the network of protein complex, increasing the binding force and influence in the technological properties of foods.

**Key Words:** dairy product, texture profile, interaction protein

### M76 Effect of breed on the physicochemical and textural characteristics of South African artisanal cheese. F. Nyamakwere1, E. Raffrenato1, M. Busti3, P. A. Gouws2, K. Dzama1, and G. Esposito*1,3

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**Key Words:** physicochemical, textural, South African artisanal cheese, buffalo, texture profile, interaction protein, multivariate analysis of variance, XLSTAT, Addinsoft Inc., New York, NY.
Breed plays an important role on milk quality and consequently, cheese quality. Little work has been done to evaluate the quality of artisanal cheeses produced from different breeds in rural small-scale farms in South Africa. The objective of the study was to investigate the effect of 3 breeds i.e., Holstein-Friesian (HF), Jersey, and cross (cross of both), on cheese physicochemical and textural characteristics. The cheeses were manufactured in 2 different farms using raw milk under artisanal processing conditions. Aging (60 d) was conducted in 2 different chambers, that is, a control (10–12°C and humidity 80–90%) and a traditional simulation (18°C and humidity 60–70%) using a domestic air conditioner and humidifier which are affordable and accessible by rural farmers. Data were analyzed using a factorial arrangement of treatments with breed and chamber, and their interaction, as fixed factors and farm as random factor. As expected, Jerseys yielded more (P < 0.05) cheese (8.6 ± 0.37) compared with HF (8.1 ± 0.40) and cross (8.2 ± 0.40) per 100 L of milk. The cheeses from the 3 breeds showed differences (P < 0.05) on their initial (d 1) values for moisture, water activity, protein, fat, free fatty acids (FFA’s), water soluble nitrogen (WSN)/total N (TN) %, salt, hardness, chewiness, yellowness, chroma and hue angle. After aging, the HF compared with Jersey and cross, had higher (P < 0.05) ash% (3.9 ± 0.13 vs 3.5 ± 0.10 vs 3.3 ± 0.14), fat% (36.6 ± 1.47 vs 31.5 ± 1.14 vs 32.4 ± 1.50) and salt% (2.0 ± 0.11 ± 1.4 ± 0.08 vs 1.5 ± 0.13) content, whereas pH, protein, FFA’s, non-protein N, WSN and WSN/TN of all cheeses were similar between breeds. For color, breed only had an effect (P < 0.05) on the yellowness which was higher in the Jersey (27.3 ± 0.33) compared with Holstein (23.1 ± 0.72) and cross (23.2 ± 0.51). Cheese from mixed breed had higher (P < 0.05) hardness and chewiness. There were interactions between the breed and aging chamber, with HF in the traditional chamber having lower (P < 0.05) moisture and water activity, and higher (P < 0.05) protein and fat content. These results are important for rural small-scale cheese producers to select ideal breeds and aging conditions for optimal production.

**Key Words:** breed, cheese quality, small scale farmers

**M78 Development of a rapid method using near-infrared spectroscopy to quantify starch and cellulose present in shredded Asiago, Parmesan, and Romano cheeses.** L. Vázquez-Portalatín* and T. C. Schoenfuss, University of Minnesota, Saint Paul, MN.

Flow-aids consisting of starch and cellulose are added to prevent caking in grated cheeses and are used as carriers for added antimycotics. The accurate quantification of these flow-aids involves difficult wet-chemistry methods. When too little antimycotic is added, quality issues can occur. Conversely, when too much flow-aid is added to dilute the cheese for economic gain, the reputation of the dairy industry is damaged. As a way to prevent the over or underuse of these ingredients, Fourier transform near-infrared spectroscopy (NIR) could be useful. The goal of this research was to investigate whether calibrations could be made to quantify starch and cellulose in Asiago, Parmesan, and Romano cheeses, alone and separately. Samples of Asiago, Parmesan, and Romano loaves were shredded, and 0 to 5.66% of a starch/cellulose flow-aid was added. Treatments were ground, weighed, formed into a ball and pressed in the middle of the glass Petri dish with a force of 280 N for 1 min to create a homogenous scanning surface. Samples were scanned using a Buchi NIRFlex N-500 FT-NIR spectrometer (BUCHI Labortechnik AG, CH). NIRCalc 5.2 Chemometric Software (BUCHI Labortechnik) was used to analyze the spectra after first dividing the spectra of the 2,367 samples into 1,578 calibrations and 789 validation samples. The spectra were treated with standard normal variate to minimize variations and optimize the calibration. The calibration obtained has an $r^2$ of 0.9906 and a Sdev of 0.1504. Future research will determine if cellulose and starch can be identified and quantified separately in the same sample, and the effect of different starch and cellulose types on quantification.

**Key Words:** near infrared, starch, cellulose

**M77 A survey on commercial US manufactured direct-salted block Gouda cheeses.** Y. Gong1, S. Govindasamy-Lucey2, J. J. Jaeggi2, M. E. Johnson2, and J. A. Lucey1,2, 1University of Wisconsin–Madison, Madison, WI, 2Wisconsin Center for Dairy Research, Madison, WI.

Recently, cheesemakers in the United States have started making direct-salted block Gouda (DG) cheese in contrast to traditional brine-salted Gouda (TG) cheese. This approach allows cheesemakers to produce Gouda cheese using existing Cheddar equipment. We compared 6 DG cheeses (DG1-DG6) and 1 TG by analyzing for compositional, proteolysis, functional and sensory properties. All 7 cheeses were commercially produced from different facilities and received at 3 mo. They were ripened at 4°C and tested at 3, 6, and 9 mo. There were compositional differences between cheeses; the DG cheeses had higher moisture (39.1–44.2%), salt (1.5–1.9%), but lower fat (29.0–32.2%), and protein (21.5–24.4%) compared with TG (moisture = 34.7%, salt = 1.4%, fat = 33.8%, protein = 26.2%). TG had the highest pH values (5.44–5.56) during ripening. Cheese functionality was assessed using dynamic low-amplitude oscillatory rheology and texture profile analysis (TPA). Data were statistically evaluated using Duncan’s test. There were differences (P < 0.05) in the crossover (melt) temperature and TPA hardness values among the DG and TG cheeses. Flavor, texture, shred properties, and pizza performance were evaluated by trained panelists using quantitative descriptive analysis. TG cheese had different sensory properties from DG cheeses; TG cheese was associated with firmness, buttery and sweet flavors. Principal component analysis (PCA) analyses on shred properties showed that TG was grouped with DG1 and DG3, and separated from others based on higher shred length and straightness values (PC1+PC2 > 95%). These cheeses also had higher TPA hardness and melt temperature. The rest of the DG cheeses were associated with more matting, surface oil and shred adhesiveness. The performance of the cheeses differed when melted on pizzas. TG had the lowest blister color value (~1.9) compared with DG (5.0–9.8) during ripening. PCA analyses showed that there were 4 groupings based on the melt properties; TG and DG3 were grouped together and associated with more skinning, higher hardness values and more free oil (PC1+PC2 > 85%). Overall, the results showed there was variation among the DG cheeses.

**Key Words:** commercial Gouda cheese, cheese performance
system for *Lactobacillus rhamnosus* GG (LGG) by using milk protein hybrid delivery system (MPHDS) and assess the survival rate of LGG during manufacture, storage, and exposure to the simulated gastrointestinal condition. MPHDS were prepared by using chymosin at a various temperature from 25 to 40°C for 10 min and holding time from 5 to 30 min at 25°C. The initial amount of LGG added in the preparation process with approximately 9.34 log cfu/mL and enumerated by pour plate counts in MRS agar incubated at 37°C for 48 h. All measurements were performed on 3 independent samples. The microparticles obtained were rather similar in shape (globular shape) and size (around 5 to 28 μm) in confocal laser scanning microscopy images and particle size analyzer. The encapsulation efficiency of different encapsulation treatments was increased significantly (*P* < 0.05) from 66.5% to 80.3%, respectively.

The viability rate during manufacture using heat temperature at 65°C for 30 min and storage at 4°C for 7 d was 71.4% to 77.6% and 76.1% to 80.3% significantly (*P* < 0.05) higher compared with free probiotics. Furthermore, the survival rate after gastrointestinal juice exposure of all prepared microcapsules was more than 70% in simulated gastrointestinal juice (pH 2.0) and 72% in simulated intestinal juice (pH 7.5) compare with free probiotics. In conclusion, encapsulation of probiotics effectively protected LGG against adverse condition such as heat treatment, storage, and gastrointestinal conditions.

**Key Words:** milk protein, *Lactobacillus rhamnosus* GG, microencapsulation