Dairy Foods I: Cheese

M104 Effect of feed selenium supplementation on dairy cattle Se transformation and cheese antioxidant activity. Z. Liu1, Y. Xiao2, C. Wang3,1, J. Liu1, and D. Ren*1, 1Institute of Dairy Science, College of Animal Science, Zhejiang University, Hangzhou, Zhejiang, China, 2Institute of Quality and Standard for Agro-products, Zhejiang Academy of Agricultural Sciences, Hangzhou, Zhejiang, China, 3College of Animal Science and Technology, Zhejiang A&F University, Hangzhou, Zhejiang, China.

Selenium (Se) is an essential micronutrient important to human and animal health. China is one of the countries experiencing serious Se deficiency. Our previous study found feed Se supply could improve Se content in milk. In the present study, the effects of milk Se additives; that is, Se-Met and Se-Yeast, on raw milk and cheese Se content, Se transformation in milk, blood, urine and feces, and antioxidant activity of cheese after 2 mo storage were compared. Three groups of 24 multiparous Jersey cows in mid-lactation were selected in local dairy farm. The first group as control received the basal diet; the second group received the basal diet with Se-Met (0.3 mg Se/kg DM), and the third group received the basal diet with Se-Yeast (0.3 mg Se/kg DM). After 2 mo feeding, milk Se content in the Se-Met group (76.5 µg/L) was higher than in the Se-Yeast group (59.5 µg/L). Se content in milk, blood, urine and feces were also compared, both Se-Met and Se-Yeast group was significantly higher than control. For the milk Se transformation, the Se-Met group (9.58%) is higher than Se-Yeast (8.45%) and control (7.91%). Using this Se-enrich milk make mozzarella cheese, a relatively high Se content was found in the Se-Met Mozzarella cheese (488 µg/kg) and Se-Yeast (415 µg/kg) than control (272 µg/kg). Antioxidant activity of cheese was evaluated by DPPH and reducing powder. For both index, Se-enriched cheeses showed higher values than control, whereas a similar result was found between Se-Met and Se-Yeast. Results of this study showed that both Se-Met and Se-Yeast supplementations could improve Se content in Jersey milk and cheese. The antioxidant activity of the Se-enriched cheese also improved, which may be of importance for human health.

Key Words: Se-Yeast, Se-Met, antioxidant activity

M105 Impact of inulin on the quality parameters of low-fat Cheddar cheese. M. S. Murtaza*1, A. Sameen2, M. A. Murtaza1, and U. Farooq1, 1Department of Food Science and Technology, Muhammad Nawaz Shareef University of Agriculture, Multan, Punjab, Pakistan, 2National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Punjab, Pakistan, 3Institute of Food Science and Nutrition, University of Sargodha, Sargodha, Punjab, Pakistan.

Low-fat cheese is the demand of this era due to overconsumption and sedentary life style and increase in diseases such as hypertension, obesity, and cardiovascular diseases. Despite its fat content, cheese is a good source of valuable protein and peptides and a good source for lactose intolerant people. Removal of fat causes various quality problems so fat must be replaced with a fat-replacing agent and inulin is a good choice. Inulin is a food ingredient that belongs a class of carbohydrates known as fructans with degree of polymerization range from 2 to 70. Chemical structure is linear fructan with (2–1)-linked β-D-fructosyl units. Fructan with degree of polymerization <10 are called fructo-oligosaccharides. They have functional and health-promoting properties as they reduce caloric value, add dietary fiber, and endorse prebiotic effects. Inulin is frequently used in industrially processed dairy as a bulking agent for fat replacement, textural modifications, and organoleptic improvements. Hence, inulin can be used in manufacturing different kind of cheeses to have reduced or low fat, texturized or symbiotic product. The present study was designed to evaluate the effect of different levels of inulin in low-fat Cheddar cheese to improve its quality. Different levels of inulin have significant effects on the physico-chemical (moisture, fat, protein, ash) characters. Meltability and flowability showed inverse relationship with levels of inulin. Meltability and flowability decreased with increasing inulin and increasing hardness. Maximum meltability and flowability was noted in I4 as 54.00 mm and 18.70% respectively. Yield calculation showed nonsignificant effect within levels but significant effect as compared with control. The fat substituting property is based on its ability to stabilize the structure of aqueous phase, which improves creaminess. The addition of inulin as fat replacement improved the sensory characteristics of low fat cheese samples when added up to the level of 0.5% inulin. Increase in inulin levels in cheese samples decreases the scores awarded for various parameters.

Key Words: meltability, flowability, hardness

M106 Development of a rapid method using near-infrared spectroscopy to quantify starch in shredded mozzarella cheese. L. Vázquez-Portalatin* and T. C. Schoenfuss, University of Minnesota, Saint Paul, MN.

Shredded mozzarella cheese poses challenges for manufacturers and consumers due to stickiness during shredding, caking of shreds, or growth of mold after packing. One solution is to add starch or cellulose-based flow aids, often with oxygen scavengers or antimycotics. Companies need to be able to quantify the flow-aid for quality assurance reasons, and to protect themselves from fraud when purchasing shredded cheese from others. Starch and cellulose wet chemistry methods are time consuming and require highly trained analysts. We developed a rapid method to quantify starch in shredded mozzarella using Fourier transform near-infrared spectroscopy (FT-NIR). Samples of low-moisture part-skim mozzarella loaves were shredded, and 0 to 10% 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 300 N for 1 min to create a homogeneous scanning surface. Samples were scanned using a Buchi NIRFlex N-500 FT-NIR spectrometer (Buchi Labortechnik AG, CH). NIRCals 5.2 Chemometric Software (Buchi Labortechnik) was used to analyze the spectra after first dividing the spectra of the 154 samples into 102 calibration sets and 52 validation sets. Reducing wavelength regions, adjusting the number of principal components, and pretreatment of spectra using Standard Normal Variate to minimize sample presentation variations, optimized the calibration. The resulting calibration was accurate with an R2 of 0.9872, and a SD of 0.3321 when full-fat cheese >4 wk post-purchase, and smoked mozzarella were removed as outliers. 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. It is likely that different calibrations will be necessary to quantify smoked, aged, and full-fat mozzarella.

Key Words: mozzarella, flow-aid
M107  **β-Lactam antibiotics in goat’s milk affecting the characteristics of mature cheeses.** P. Quintanilla1, M. C. Beltrán1, A. Molina2, I. Escriche1, and M. P. Molina*1, 1Universitat Politècnica de València, Valencia, Spain, 2Universidad de Castilla-La Mancha, Albacete, Spain.

Antibiotic residues in milk may pose a risk for public health and for the dairy industry, especially in fermented products such as cheeses. The objective of this study was to analyze the effect of β-lactams (amoxicillin, benzylpenicillin, and cloxacillin) in goat’s milk on the biochemical and texture characteristics of semi-hard Tronchón cheese. Milk from Murciano-Granadina goats with a good health status and not having received any veterinary drugs was used. The milk was spiked with β-lactam concentrations equivalent to their maximum residue limit (MRL) and ripened cheeses were made. One batch of cheeses from raw antibiotic-free milk was used as control. The proteolysis level was determined by free amino acids content (FAA, mg of leucine/g of cheese), the lipolysis level measured as the free fatty acids concentration (FFA, mEq KOH/100 g of fat) and texture parameters assessed by texture profile analysis (TPA: hardness, adhesiveness, springiness, cohesiveness, chewiness). Also, the residual concentration of antibiotics by HPLC-MS/MS in cheeses ripened for different periods (1, 30, and 60 d) was studied. The presence of amoxicillin in milk at MRL affected the FFA concentration in cheeses, being lower in antibiotic-spiked cheeses compared with control cheeses (2.21 vs. 2.67 mEq KOH/100 g of fat). However, the presence of benzylpenicillin in milk did not have any negative effects on the cheese properties. While, in cheeses made from cloxacillin spiked milk FFA concentration being lower than in control cheeses (2.40 vs. 2.67 mEq KOH/100 g of fat), also springiness was affected likewise (0.60 vs. 0.63). Amoxicillin (<2 µg/kg), benzylpenicillin (4.8 ± 1.8 µg/kg) and cloxacillin (28.8 ± 1.7 µg/kg) residual amounts were quantified at beginning of ripening (1 d), while antibiotic residues were not detected in the cheese at the end of ripening (60 d). It can be concluded that the β-lactam residue concentrations in matured goat’s cheeses do not represent a potential public health risk. Nevertheless, similar studies with other antibiotic groups and using different cheese-making processes are recommended.

**Key Words:** β-lactam antibiotic, goat milk, ripened goat cheese

M108  **Influence of increasing milk protein concentration from 4 to 9% using ultrafiltration on Cheddar cheese pH and moisture.** M. M. Motawee1 and D. J. McMahon1, Western Dairy Center, Utah State University, Logan, UT, 2Department of Nutritional Evaluation and Food Sciences, National Organization for Drug Control and Research, Giza, Egypt.

Increasing protein levels of milk influences rate of whey expulsion during cheesemaking and buffering capacity of curd, which in turn influences moisture and pH of cheese. Our objective was to develop manufacturing procedures for making Cheddar cheese using milk containing 4 to 9% protein. Pasteurized milk was ultrafiltered to ~3.5× concentration then diluted with permeate to required protein levels. A time-standardized make procedure was prepared based on ~4 to 12 kg of milk such that each mini-vat contained ~400 g of casein. Acidification was by adding ~0.5% of a pH-controlled bulk starter. The milk was renneted and before cutting, 1.5 kg of permeate was overlaid upon the curd to minimize curd breakage upon stirring and facilitate curd syneresis. The pH and moisture of curd was monitored during cheesemaking and in the final cheese. Whey expulsion decreased as protein concentration increased such that curd made from 9% protein milk was lower (P < 0.05) in moisture than curd made from 4% protein milk after cooking and before draining. After cheddaring, milling and salting there was slight but not statistically significant differences in curd moisture. The final cheeses made using higher protein concentrations were about 1% lower in moisture than those made at the lower concentrations (R² = 0.55). Even though culture was standardized to protein concentration, this did not completely compensate for increased buffering capacity of the curd and there was less pH drop during cheesemaking as protein level increased: with differences of 0.1 units before draining and 0.2 units before pressing, such that the pH after 1 d increased from pH 4.9 to pH 5.1 for cheese made from 4% and 9% protein milk, respectively. During 30 d of storage, the pH of the cheese increased ~0.2 units. In conclusion, provided the starter activity added is increased to match the protein concentration, and permeate is added to help float the curd upon cutting, Cheddar cheese can be manufactured within moisture and pH targets with milk containing up to 9% protein.

**Key Words:** concentrated milk, ultrafiltration, starter culture

M109  **Method development to quantify paste stability for surface mold-ripened cheeses.** D. Batty*, J. Waite-Cusic, and L. Meunier-Goddik, Oregon State University, Corvallis, OR.

Surface mold-ripened cheeses undergo biochemical reactions during ripening that transform the curd from firm and chalky to soft and flowable over a short ripening period (3–12 wk). The degree and rate of softening varies depending on the procedure used for manufacture (lactic curd vs stabilized curd). The objective of this study was to objectively quantify the degree of paste stability for surface mold-ripened cheeses using a method that accounts for their heterogeneous consistency during maturation. In this study, 5 varieties of Camembert type cheese were manufactured using different cheese making procedures in triplicate and measured for composition. The paste displacement was quantitatively measured 35 and 50 d post manufacture. Cheese wheels (7 cm in diameter) were separated by a vertical cross sectional cut in the middle of the wheel. The initial temperature was 7°C at the start of the test. The paste displacement (flow) distance was measured at the furthest point it traveled away from the cheeses after 15, 30, 45, and 60 min. There were significant differences (P < 0.05) between the varieties, most notably between the lactic curd (furthest displacement), washed curd (middle displacement), and stabilized curd (least displacement) varieties. After 35 d of maturation and 60 min in to the test the lactic curd, washed curd, and stabilized curd traveled average distance of 24 ± 3.4 mm, 7 ± 1 mm, and 3 ± 0.7 mm and after 50 d of maturation the distance traveled was 27 ± 1.9 mm, 19 ± 2.1 mm, and 4 ± 0.3 mm. An objective method for quantifying paste stability of non-homogeneous cheeses can help determine the level of paste stability in soft ripened cheeses, maturity of the cheese, as well as help cheese makers to optimize cheese recipes for customer requirements. Further investigation using various cheese wheel sizes will be necessary to verify this method is applicable to all cheese sizes.

**Key Words:** soft cheese, rheology, paste stability

M110  **The effect of high hydrostatic pressure on the microbiological quality and shelf life of Camembert-type cheese.** D. Batty*, A. Emch, L. Meunier-Goddik, and J. Waite-Cusic, Oregon State University, Corvallis, OR.

Surface-ripened cheeses, such as Camembert, typically have a short shelf life and are susceptible to contamination by environmental pathogens. High hydrostatic pressure processing (HPP) has been shown to be effective at extending shelf life and reducing pathogens post-manufacture in various food products. The objective of this study was to determine the
effect of HPP on the microbiological quality of a surface mold-ripened cheese. Three varieties of Camembert type cheese (traditional, stabilized curd, and a hybrid of the 2) were manufactured. The cheese was HPP treated (550 MPa for 10 min at 25°C) in duplicate treatments at either 3 (treatment A) or 10 d (treatment B) post manufacture. Treatment was applied either before (treatment A) or after (treatment B) surface yeast/mold growth. They were analyzed and monitored through shelf life for pH of the rind, pH of the paste, and microbiological quality (yeasts and molds, total plate count, and lactic acid bacteria). There were significant differences ($P < 0.05$) across both treatment time and types of cheese. *Penicillium candidum* had the largest decrease post-HPP with an average reduction of $2.3 \pm 0.1 \log \text{cfu/g}$ across all varieties 7 d after manufacture. At 21 d post manufacture there was an average reduction of $1.0 \pm 0.3 \log \text{cfu/g}$ for treatment A and $3.8 \pm 0.8 \log \text{cfu/g}$ for treatment B. The pH of the rind, another critical parameter for Camembert maturation and surface mold growth, was significantly lower after 14 d with treatment A having an average decrease of $1.69 \pm 0.3$ units (from 7.52 to 5.83) and treatment B decreasing by $2.36 \pm 0.1$ units (from 7.52 to 5.16) compared with the non-treated cheeses. Our study demonstrates that HPP of Camembert type cheese has a negative effect on the surface mold. However, HPP of cheeses before mold growth has a less negative effect on mold compared with pressure treating following surface mold development, indicating that HPP treatment time will influence the microbiological quality of surface-ripened cheeses.

**Key Words:** *Penicillium candidum*, pH, high pressure processing treatment time