790 Studies on the application of dielectric spectroscopy for the measurement of process cheese functionality. J. Amamcharla*[1], L. E. Metzger[1], O. Grace[2], and C. Jones[2], [1]*Midwest Dairy Foods Research Center, Dairy Science Department, South Dakota State University*, *Brookings,* [2]*Biosystems and Agricultural Engineering, Oklahoma State University*, *Stillwater*.

This study evaluated the potential of dielectric analysis of process cheese for prediction of the textural (hardness) and melting properties. Process cheeses (n = 24) with similar composition (fat, protein, moisture, and salt) were procured from a commercial manufacturer (Bongards' Creameries, MN). Dielectric properties (permittivity (ε′) and loss factor (ε″)) of the process cheeses were collected over the frequency range 0.2 – 3.2 GHz at a constant temperature (25°C). Dielectric measurements were made using an open-ended high temperature dielectric Probe (model: 8710–2036; Agilent Technologies, Englewood, CO) connected to a vector network analyzer (model: N5320A; Agilent Technologies). The system was calibrated using distilled water at 25°C, air and a short circuit mode. Dielectric spectra were collected in triplicate at 4 different locations on each sample. The replicates with a standard deviation less than 4% were selected and averaged to get a single dielectric spectrum for each sample. A decrease in the ε′ and ε″ was observed as the incident frequency increased for all process cheeses. Partial least square regression (PLSR) models were developed using the dielectric spectra of process cheeses to predict the hardness (gf), melting point (°C) and modified Schreiber melt diameter (mm) of process cheese. Penetrometer, dynamic stress rheometry (DSR), and modified Schreiber melt (MSM) test were used as respective reference methods. The PLSR models were validated using the full cross-validation method. Root mean square error of crossvalidation was found to be 1.41°C, 1.25 mm, and 11.64 gf for DSR melt point, MSM diameter, and hardness of process cheese, respectively. Correlation coefficients of 0.94, 0.91, and 0.91 were observed for process cheese functional parameter and the dielectric spectra. Practical utility of the calibration models were evaluated using the range error ratio (RER). The RER was found to be > 8 for the 3 functional properties, indicting a limited to good practical utility. Further validation of the results on a larger data set will be necessary.

Key Words: dielectric spectroscopy, process cheese, functional properties

791 The effect of NaCl/KCl substitution on Halloumi cheese during storage: Chemical composition, proteolysis, texture profile, and microstructure. M. M. Ayyash* and N. P. Shah, *Victoria University*, *Melbourne, VIC, Australia*.

The effect of partial substitution of NaCl with KCl on chemical composition, LAB count, organic acids profile, proteolytic pattern, texture profile, and microstructure of Halloumi cheese was investigated. Halloumi cheeses were made and kept in 4 different brine solutions (at 18%) including NaCl only (HA), 3NaCl:1KCl (HB), 1NaCl:1KCl (HC), and 1NaCl:3KCl (HD) and then stored at 4oC for 56 d. Chemical composition, proteolysis, texture profile and microstructure were analyzed. No significant ($P > 0.05$) effect was observed between control and experimental cheeses in terms of composition and LAB count and pH values at the same storage period. At same salting treatment, moisture content decreased significantly while LAB count significantly ($P < 0.05$) increased. There was a significant ($P < 0.05$) difference in ash, sodium and potassium contents among cheeses at the same storage period. However, these parameters increased ($P < 0.05$) during storage at same salt treatment. There was no significant ($P > 0.05$) difference in lactic and citric acid contents among cheeses. In contrary, there was a significant ($P > 0.05$) difference in acetic acid concentration among cheeses. There were no significant ($P > 0.05$) differences in WSN, TCA-SN, and PTA-SN of experimental cheeses at same storage period. However, these parameters increased ($P < 0.05$) during storage at same salt treatment. Peptide pattern and urea-PAGE also showed no significant difference among experimental cheeses. There was no significant difference in TPA parameters between cheeses at same storage period. At same salt treatment, hardness, and cohesiveness decreased ($P < 0.05$) and adhesiveness increased ($P < 0.05$) during storage period. ESEM images showed compact and closed texture in all experimental cheeses. Our results showed that Halloumi cheeses can be stored in brine solution partly substituted with KCl without any adverse effect on their quality.

Key Words: Halloumi cheese, NaCl/KCl, chemical composition

792 Influence of NaCl reduction on the properties of Cheddar cheese. K. V. Grant*[1], S. Govindasamy-Lucey[2], J. A. Lucey[1], J. J. Jaeggi[2], M. E. Johnson[2], and S. A. Rankin[1], [1]*University of Wisconsin*, *Madison*, [2]*Wisconsin Center for Dairy Research*, *Madison*.

Reducing sodium in processed foods is a current trend in the food industry. The goal of our research is to develop reduced NaCl Cheddar cheese with acceptable body and flavor. To better understand the many roles of NaCl in cheese we studied the properties of Cheddar cheese with 3 NaCl levels: normal (1.7%), reduced (1.2%), low (0.7%). Curds were prepared using traditional Cheddar manufacturing, then subdivided into 6 batches and salted at the 3 levels, each in duplicate. Analysis was performed at 4 d, 3 wk, 5 wk, 3 and 6 mo. Within the first 5 wks of ripening there were significant differences in cheeses. Differences in moisture content and water activity were found: 37.0% and 0.970; 36.2% and 0.959; and 34.1% and 0.955 in normal, reduced and low NaCl cheese, respectively. The starter culture numbers also differed by 5 wks of ripening: 1.49×10^9, 1.04×10^9, and 7.44×10^8 CFU/mL for normal, reduced, and low NaCl cheese, respectively. Texture profile analysis revealed a significantly softer ($P < 0.01$) texture of low NaCl Cheddar compared to reduced and normal NaCl cheeses at 3 and 5 wks. Rheological small amplitude oscillatory shear tests indicated differences in loss tangent (LT) values during heating. A LT value of 1 is often used as a melting point. At 5 wks of aging the temperature where LT=1 was 50.4, 48.4 and 47.4°C for normal, reduced and low NaCl cheeses. Sensory analysis of the cheese was performed using a trained sensory panel (n=16) after 5 wks of ripening. Panelists found the lower NaCl cheeses to be significantly more acidic ($P < 0.005$) with a higher total off-flavor intensity ($P < 0.05$) and lower Cheddar flavor acceptability ($P < 0.005$).
This work shows that reducing the NaCl level in Cheddar cheese impacted starter culture growth, texture, meltability and flavor acceptability. The wide-ranging impact of NaCl reduction on cheese suggests that a range of approaches, such as addition of flavor enhancers and antimicrobials will be needed to increase the acceptability of low NaCl cheeses. This study provides a benchmark for our ongoing work on approaches to improve low NaCl Cheddar cheese. Results for cheese aged 3 and 6 mo will be reported.

Key Words: low sodium, Cheddar cheese

793 Influence of sodium gluconate on flavor and microbiology of low fat Cheddar cheese. D. J. McMahon*[1], C. J. Oberg[2], L. Moyes[2], R. E. Miracle[3], and M. A. Drake[3], [1]*Western Dairy Center, Utah State University*, *Logan,* [2]*Microbiology Department, Weber State University*, *Ogden, UT,* [3]*Southeast Dairy Foods Research Center, North Carolina State University*, *Raleigh.*

Low fat cheese manufactured using *Lactococcus lactis* ssp. *lactis* generally develops a flavor profile during aging uncharacteristic of Cheddar cheese. Such cheeses can have rosey aroma and taste as well as a pronounced burnt-brothy-bitter taste. The objective of this research was to determine if sodium gluconate (SG) addition during cheesemaking could ameliorate low fat cheese flavor. Cheese (in duplicate) was made using 700 kg of milk using a stirred curd method with SG added during salting to produce 4 blocks that were about 6% fat, 53% to 54% moisture, 1.7% to 1.8% salt, pH 5.0 to 5.3, and SG addition levels of 0% (control), 0.8%, 1.6% and 2.4%. The cheese was stored at 6°C and analyzed monthly for total lactic acid bacteria (LAB), lactococci, and nonstarter LAB (NSLAB) (i.e., *Lactobacillus casei*-type bacteria) using selective media. Cheese was analyzed at 4 and 6 mo for flavor profile using descriptive sensory analysis (15-point scale) and for compounds suspected of contributing to rosey and burnt off-flavors in low fat cheese. Adding SG did not change the LAB, lactococcal or NSLAB populations. Irrespective of SG addition, lactococcal populations gradually decreased during the first 5 mo of storage to about 10^4 cfu/g while NSLAB increased from their initial low level to high levels (10^7 to 10^8 cfu/g) within 30 d and remained the dominant LAB throughout storage. At 4 mo, cheeses all had rosey and burnt flavors with no differences ($P > 0.05$) in flavor except for a slight trend ($P < 0.05$) for increased saltiness with SG (3.5 for 2.4% SG cheese compared with 3.2 for control). At 6 mo, similar results were obtained and some bitterness was detected (absent at 4 mo) with the 1.6% and 2.4% SG cheeses having less ($P < 0.05$) apparent bitterness than the control cheese (0.5 compared with 1.0). Phenyl ethanal, phenyl ethanol, sotolone, or furaneol varied between replicates but not between treatments ($P > 0.05$). Homofuraneol and phenyl acetic acid were lower ($P < 0.05$) in the cheeses with 1.6% and 2.4% SG than in the control or cheese with 0.8% SG. This suggests that adding SG might be masking the bitter taste associated with burnt flavor in low fat Cheddar cheese.

Key Words: low fat, burnt flavor, microflora

794 Optimization of the manufacture of a no-fat added reduced-sodium processed cheese (Requeijão cremoso). L. M. Spadoti, A. G. F. Van Dender, P. B. Zacarchenco*, F. K. H. S. Trento, A. T. S. Alves, T. Q. Mendes, R. C. S. C. Ormenese, M. A. Morgano, and K. Yotsuyanagi, *Instituto de Tecnologia de Alimentos-ITAL*, *Brazil*.

The increased incidence of cardiovascular diseases caused by hypertension and obesity have heightened consumer awareness of nutrition and healthy eating. Within this context, the demand for foods with reduced levels of fat and/or sodium has greatly increased. Requeijão cremoso is a genuinely Brazilian processed cheese with a mild flavor, clear and shiny in color, and a creamy and elastic texture forming long strings. However, as with most cheeses, it is a source of fat and salt (sodium chloride). In view of the high consumption of this cheese in Brazil, and the current demand for healthier foods, no–fat added reduced-sodium requeijão (NFARSR) similar to the traditional product as to the main characteristics of flavor, texture and composition would be an important alternative to meet the needs of the changing market. In this study, the fat in requeijão was replaced by whey protein concentrate (WPC34%), while sodium reduction was achieved by replacing 40% of the sodium chloride by potassium chloride and by partially replacing the traditional, sodium phosphate-based emulsifying salt (Joha S9) by a potassium phosphate-based emulsifying salt (Joha S9K). The objective of this study was to optimize the use of the emulsifying salt combination (JohaS9+JohaS9K) to reduce the sodium level of an existing no–fat requeijão developed at Tecnolat–ITAL. For this purpose, a 2^2 factorial design with 2 factors (JohaS9 and JohaS9K), 2 levels (+1, −1) with 3 repetitions at the central point was used, resulting in 11 experimental trails. The results were evaluated by the surface response method to assess physical–chemical, sensory and instrumental texture parameters. Analysis of the surface response graphs, and especially the comments made by sensory panelists regarding flavor and texture, showed that RB4 – made with a mixture of 1.0% JohaS9 and 0.8% Joha S9K – was the NFARSR formulation that best met the preset specifications.

Key Words: reduced-sodium, processed cheese, cheese

795 Consumer flavor preferences and level of aged Cheddar cheese flavor. D. J. McMahon* and R. Wadhwani, *Western Dairy Center, Utah State University*, *Logan.*

Development of new cheese products such as low fat cheeses often have the goal of duplicating the flavor of the full fat counterpart. Sensory panels involving untrained consumers are often used to determine if a desired flavor profile is obtained Four sets of cheeses were obtained that including cheeses from 2 different manufacturers (designated A and B) that were labeled as mild, medium, sharp or extra sharp were purchased locally. A second set of Cheddar cheeses (designated C and D) were obtained from Utah State University (USU) that were 3, 6 and 12 mo of age and designated as mild, medium and sharp. All cheeses were tested by a trained descriptive cheese panel to produce a flavor profile for each cheese. Then 2 different consumer sensory panels (n = 120 for each panel) were conducted in which consumers were asked about their cheese flavor preferences, their cheese buying frequency, the form of cheese they buy and how they use cheese. They were then presented with 2 sets of cheeses (one commercial and one USU cheese) for overall liking using a 9-point hedonic scale and for flavor, texture, chewiness, and level of sharpness using a 5-point Just About Right (JAR) scale with 1 being "too little," 3 being "just about right" and 5 being "too much" of the attribute. Panelist responses were recorded via computer keyboard using SIMS 2000 software. The cheese panelists were from 18 to 35 years of age, with >60% being frequent cheese consumers. The majority of the panelists stated that they preferred to buy medium Cheddar cheese followed by sharp aged, mild with extra sharp being the least preferred. The 4 sets of cheeses had different flavor profiles ($P < 0.05$) and their overall liking scores were significantly different ($P < 0.05$) and ranged from a high of 6.82 for cheese A-mild to 4.87 for cheese B-sharp. The other top-ranked cheeses were C-mild, D-mild, B-medium. The 4 sharp cheeses had the lowest scores ($P < 0.05$). On the JAR scale the cheese with scores closest to JAR were C-medium, D-medium, A-medium for flavor; C-medium. C-sharp, and A-sharp; while for chewiness it was A-mild, C-medium and C-sharp. JAR thus matched better with consumer stated preferences.

Key Words: Cheddar, flavor, sensory

796 Nutritional and organoleptic quality of Cheddar cheese prepared from goat and buffalo milk blends. M. Nasir*, H. Jabeen, M. Abdullah, M. A. Jabbar, and M. A. Ali, *University of Veterinary and Animal Sciences*, *Lahore, Punjab, Pakistan*.

The goat milk in developing countries like Pakistan is not usually processed and its value in human nutrition has so far received very little factual attention from researchers and manufacturers. Thus the present

research project was designed to assess the feasibility of buffalo milk replacement with goat milk for Cheddar cheese manufacturing. Goat and buffalo milk were blended at various levels (25:75, 50:50, 75:25; goat milk: buffalo milk) and used along with 100% buffalo and 100% goat milk for Cheddar cheese preparation. The cheese thus prepared was subjected to different physicochemical analysis i.e., fat, protein, lactose, ash, total solids, SNF, amino acids, fatty acids, organic acids, pH, acidity and sensory evaluation at 0, 30, 60, 90 and 120 d of storage intervals. The data thus obtained was analyzed through ANOVA technique by applying 2-way CRD and the level of significance was defined as $P \leq 0.05$. Buffalo milk contained significantly ($P \leq 0.05$) more total solids and fat and less protein content as compared with goat milk. Therefore the addition of goat milk resulted in decreased fat and total solids, however there was progressive increase in protein content in cheese with the level of goat milk. pH and acidity of the cheese were not affected by the milk type, however there was decrease in pH and increase in acidity with storage period. Although, there was significant ($P \leq 0.05$) change in various fatty acids, organic acids and amino acid with level of goat milk in cheese samples, yet it had non-significant ($P \geq 0.05$) effect on the overall sensory quality of the finished product except for the attributes of flavor and overall acceptability beyond 50% goat milk level in samples; having significantly ($P \leq 0.05$) lower scores. The highest scores for most of the sensory parameters were awarded to the samples at 90 d storage interval. Thus, it is concluded that the Cheddar cheese with good nutritional profile and high acceptable quality can be made with up to 50% replacement of buffalo milk with goat milk, and may be recommended for commercial application.

Key Words: goat milk, Cheddar cheese, sensory quality