W125 Determining economic feasibility for artisan cheese companies. Cathy Durham[2], Andrea Bouma[1], and Lisbeth Goddik*[1], *[1]Department of Food Science, Oregon State University, Corvallis, OR, [2]Food Innovation Center, Oregon State University, Portland, OR.*

Artisan cheese makers lack access to valid economic data to help them evaluate business opportunities and make important business decisions such as determining cheese pricing structure. An economic model was developed in Excel following close collaboration with current and future artisan cheese companies. The objective of this study was to utilize this economic model to evaluate the net present value (NPV), internal rate of return, and pay back period for artisan cheese production at different annual production volumes for a given cheese type. The model is also used to determine the minimum retail price necessary to assure positive NPV for 5 different cheese types produced at 4 different production volumes. These 2 scenarios demonstrate important business considerations facing artisan cheese makers. For example, a small size cheese maker with annual production volume at 3,401 kg (7,500 lb) cannot be economically viable (negative NPV) if selling cow milk Gouda for $48.50/kg ($22/lb); by doubling the production size, the business would obtain a positive NPV. Due to differences in cheese yield, investment in aging facility, labor required during aging, and raw milk purchase price, fresh cow milk cheeses such as fresh mozzarella can be sold for about half the price of hard, aged, goats' milk cheeses at the largest volume or about 2-thirds the price at the lowest volume examined. For example, for the given model assumptions, at an annual production of 13,608 kg cheese (30,000 lb), a fresh cows' milk mozzarella should be sold at a minimum retail price of $27.29/kg ($12.38/lb) while a goats' milk gouda needs minimum retail price of $49.54/kg ($22.47/lb) for the business to have NPV at or above zero. The model is utilized within the OSU Extension program and has gone through 2 major updates. The observations derived from the model are consistent with the current business situation for artisan cheese companies.

W126 Effect of *terroir* for raw and pasteurized milk Cheddar on nonstarter lactic acid bacteria. Christopher Baird, Lisbeth Goddik*, Gregory Turbes, Elizabeth Tomasino, Juyun Lim, and Joy Waite-Cusic, *Department of Food Science, Oregon State University, Corvallis, OR.*

Terroir is a connection to the land and producer that influences the organoleptic properties in many products including cheese. Non-starter lactic acid bacteria (NSLAB), which are present in the environment, are thought to be one driving component of terroir in cheese. The effect of *terroir* was explored through differences in NSLAB between Cheddars made from different milk source locations. The effects of heat treatment on the importance of *terroir* on NSLAB present in cheddar was also investigated. Cheddar was produced with raw and low-temperature long-time (LTLT) pasteurized milk at Oregon State University. Milk was sourced from 3 individual farms, and 2 commingled sites in different eco-regions of Oregon. All milk was collected within 5 weeks while the Jersey herds were on a pasture-based diet. Cheddar was aged at 5°C and 2 samples per cheese were extracted at 5 and 9 mo. Samples were homogenized and grown anaerobically on MRS at 30°C for 48 h. Five random colonies were selected per for further identification. Isolates were speciated using API50 fermentation test kits. At 5 mo, the majority of isolates identified in raw and LTLT pasteurized cheddar were *Lactobacillus paracasei* and *Lactobacillus plantarum* respectively. Fermentation patterns between similar identifications showed wide variation at 5 mo with no overlap between regions. *L. paracasei* remained the dominant NSLAB in raw cheeses after 9 mo of aging. Each Cheddar showed reduced variety in NSLAB fermentation patterns at 9 mo. The unique fermentation patterns suggest that milk source location influenced the NSLAB profile of Cheddars. Further variability of isolates will be performed by pulsed field gel electrophoresis (PFGE). The NSLAB profile of cheddar is a reflection of the milk source location. This connection between NSLAB and location demonstrates one facet of *terroir* that affects Cheddar.

Key Words: nonstarter lactic acid bacteria, Cheddar, *terroir*

W127 Effect of *terroir* on flavor for raw and pasteurized milk Cheddar. Gregory Turbes, Lisbeth Goddik*, Christopher Baird, Juyun Lim, Joy Waite-Cusic, and Elizabeth Tomasino, *Department of Food Science, Oregon State University, Corvallis, OR.*

Terroir is a term that in the United States has come to be known as "taste of place." It builds off the idea that a food's organoleptic properties are defined by the environment, climate, and production practices. The effect of *terroir* and heat treatment effect on *terroir* to Oregon Cheddar flavor were explored. Cheddar was produced with raw and low-temperature long-time (LTLT) pasteurized milk at Oregon State University. Milk was sourced from 3 individual farms, and 2 commingled sites in different eco-regions of Oregon. Dairy farms were selected with similar herd management styles. Collection of milk occurred within a 5-week period while the Jersey herds were on a pasture-based diet. Cheddar was aged at 5°C and 2 samples per cheese were extracted at 5 and 9 mo of aging. Flavor compounds were analyzed using gas chromatography-mass spectrometry (GCMS). A total of 54 flavor compounds were detected. At 5 and 9 mo 46 and 30 flavor compounds were identified respectively, consisting of acetates, alcohols, aldehydes, alkanes, alkenes, esters, fatty acids, ketones, lactones, nitrogen compounds, sulfur compounds, and terpenes. Principal component analysis (PCA) was performed for all samples. At 5 mo, samples separated based on milk source location and at 9 mo samples separated based on heat treatment. Results suggest that the flavor of Cheddar is affected by both *terroir* and LTLT pasteurization; 5 mo cheddar flavor is best characterized by *terroir* and 9 mo Cheddar flavor is best characterized by heat treatment. This connection between Cheddar flavor and milk source location suggest that *terroir* is part of what characterizes a Cheddar.

Key Words: flavor, Cheddar, *terroir*

W128 The effects of *terroir* and heat treatment on consumers' perception of Cheddar cheese flavor. Gregory Turbes, Lisbeth Goddik*, Tyler Linscott, Elizabeth Tomasino, Joy Waite-Cusic, and Juyun Lim, *Department of Food Science, Oregon State University, Corvallis, OR.*

The objective of this research was to investigate the effect of *terroir* (geographical location of milk source) on Cheddar cheese flavor. Milk from 5 locations, including single dairy farms and commingled sites, were collected from around the state of Oregon: 3 individual dairy farms from the mid-valley and 2 commingled sites at coastal and high desert plateau. These farms/sites were selected based on their representation of Oregon's dairy industry as well as similarities in herd and herd management characteristics. Using raw and pasteurized counterparts of the standardized milk, Cheddar cheese was made and aged. At 5 and 9 mo

into aging, Cheddar cheese consumers were asked to sort the samples based on perceived similarity/dissimilarity of cheese flavor and also to describe the characteristics of each cheese groups. Grouping data were subjected to multidimensional scaling and subsequent cluster analysis. Correspondence analysis was also performed on consumer descriptions as a simplified exploratory approach to discover underlying characteristics. Results at 5 mo into aging revealed that consumers could differentiate cheese samples based on dairy farm origin, while cheeses produced from commingled milk samples were perceived to be similar. At 9 mo into aging, consumers differentiated the cheeses based on heat treatment; that is, raw vs. pasteurized milk cheeses. These data suggest that for younger cheeses, the geographical location of the milk source has a significant effect on the flavor of Cheddar cheese but that the practice of milk commingling may overcome the effects of geographical location. Thus we can source cheese flavor to individual farms and thereby demonstrate the existence of *terroir*. In contrast, the older cheeses are primarily characterized by their history of heat treatment.

Key Words: *terroir*, cheese, sensory

W129 Sensory and functional properties of cheese across three storage temperatures. Ni Cheng*[1], P. D. Gerard[2], and M. A. Drake[1], *[1]Southeast Dairy Foods Research Center, North Carolina State University, Raleigh, NC, [2]Dept. Mathematical Sciences, Clemson University, Clemson, SC.*

Cheese quality influences sales and applications. Storage time and temperature affect cheese quality and may play a crucial role in cheese designated for export markets as optimum quality must be maintained. A mild flavor profile is expected in export markets concurrent with optimum functional properties. The objective of this study was to evaluate sensory and functional properties of 4 cheese types across different storage temperatures. Triplicate lots (18 kg blocks)of cheeses (Cheddar, Monterey Jack, Mozzarella and Gouda) were obtained from 2 commercial facilities and assigned to 4°C, −1°C and −18°C storage. Cheeses were evaluated every 3 mo through 1 year storage. At each time point, sensory evaluation (flavor and texture) and functional tests (moisture, pH, shreddability, sliceability, color, melting, viscosity, and fork stretch) were conducted. Two-way ANOVA (storage time, temperature) as well as multivariate analyses were applied to evaluate the data. Time and storage temperatures had no practical effects on cheese composition or color ($P > 0.05$). Storage time increased shreddability and melt and decreased sliceability, viscosity and fork stretch values ($P < 0.05$). Storage at −18°C resulted in smaller increases in shreddability and melt than −1°C or 4°C. There were no differences in shreddability and melt properties for cheeses stored at 4°C or −1°C ($P > 0.05$). Across storage time, cheeses increased in intensities of typical aged cheese flavors (sulfur and brothy), cheeses stored at lower temperatures maintained young/undeveloped cheese flavors (cooked, whey, milkfat and diacteyl) longer than cheeses stored at 4°C. Texture properties by sensory analysis were unchanged through 6 mo storage, regardless of temperature. These results indicate that a lower temperature (−1°C) may be applied to cheeses for up to 6 mo to maintain sensory quality (young, mild flavor) without detrimental effects on functional properties.

Key Words: cheese, storage, quality

W130 Microstructural arrangements observed using electron microscopy during the manufacture of cheese and the influence of cheese pH. Almut H. Vollmer*, Nabil N. Youssef, and Donald J. McMahon, *Western Dairy Center, Utah State University, Logan, UT.*

It is known that the texture of cheese changes as a function of pH. Our objective was to determine the differences in the arrangements of protein and fat between a medium pH cheese (Cheddar cheese) and a low pH cheese (feta cheese). Cheese was made using 16-kg aliquots of milk and the make procedure modified to produce cheddar cheeses with a range of pH values as well as making a feta cheese. Samples of curd were collected throughout the cheese making processing, starting from before cutting the curd and during cheese storage. Samples were fixed in glutaraldehyde, then dehydrated, heavy metal stained, embedded and sectioned, and multiple fields observed using transmission electron microscopy. During initial curd formation the characteristic fine stranded network of aggregated casein micelles was observed with fat globules entrapped between the protein strands. As the cheese manufacture continued, and the curd particles contracted and whey was expelled, the initial protein strands apparently coalesced into thicker strands and the casein micelles tended to lose their individual identity. This same general pattern continued throughout manufacture and into the storage period. After 3 mo of aging the cheddar cheeses ranged from pH 4.9 to pH 5.2. There were variations in protein arrangements observed within individual cheese samples as is typical in microstructure of dairy foods. No observable differences in structural arrangements outside this natural variability were apparent between the Cheddar cheese of lowest pH to the highest pH. In contrast, the microstructure arrangements of the proteins in feta cheese were very different to those in Cheddar cheese. In feta cheese, there is a more openness present in the protein network with the appearance of the protein regions having a looser nature; that is, not having large coherent regions of connected protein. This was related to feta cheese having a pH below that at which the caseins are acid precipitated and as they become less soluble in the surrounding serum phase of the cheese. These differences in protein arrangements observed using electron microscopy helps explain the crumbly texture associated with low pH rennet-set cheeses.

Key Words: Cheddar, feta, microstructure

W131 Effect of salting pH, salting rate, and stretching temperature on proteolysis in Mozzarella cheese. Ananya C. Biswas*[1], Anil Kommineni[1], Praveen Upreti[2], and Lloyd E. Metzger[1], *[1]Dairy Science Department, South Dakota State University, Brookings, SD, [2]Nestle R&D Center Inc., Solon, OH.*

The level of proteolysis during refrigerated storage of Mozzarella cheese can have an effect on functionality including stretching and melting characteristics. Proteolysis in Mozzarella cheese could be influenced by several manufacturing parameters including: salting pH (SP), salting rate (SR), and stretching temperature (ST). The objective of this study was to evaluate the effects of SP, SR and ST on Mozzarella cheese proteolysis during storage. Thirty-two batches of Mozzarella cheese were manufactured using a partial split plot design that included a range of protein-to-fat ratios (1 to 4.5) in the main plot. In the sub plot, 2 salting pH (5.2 and 5.6), 2 salting rates (1.5% and 2.2%), and 2 stretching temperatures (65°C and 85°C) were used. After manufacture Mozzarella cheese was vacuum packed and stored at 4°C for 28 d. After storage, proteolysis was determined by measuring the soluble protein at pH 4.6 as a percentage of total protein content. Proteolysis and composition data were analyzed using simple linear regression analysis to establish potential relationships among the cheese compositions (moisture, fat, and protein), SP, SR, ST and proteolysis. Linear regression analysis indicated that proteolysis was primarily influenced by ST and cheese manufactured with the high ST always resulting in less proteolysis as compared with the low ST. Subsequently the GLM procedure of SAS was utilized to conduct an ANOVA. The results determined that milk

fat and protein content, and ST had a significant effect ($P < 0.05$) on cheese proteolysis, whereas no significant effects were observed for SP and SR. These results demonstrate that in this study milk composition and stretching temperature were the primary factors influencing proteolysis of mozzarella cheese. This information can be used by cheese manufacturers to control the level of proteolysis in Mozzarella cheese.

Key Words: milk protein-to-fat ratio, Mozzarella cheese, proteolysis

W132 Effect of selenium supplementation on Se status and Mozzarella quality in dairy cattle feed. Weizheng Zhu, Hongyun Liu*, Daxi Ren, and Jianxin Liu, *Institute of Dairy Science, College of Animal Science, Zhejiang University, Hangzhou, Zhejiang, China.*

Selenium (Se) is an important trace element and its deficiency has been associated with human and animal health. The human recommended dietary allowance (RDA) for adult Se intake is about 55 μg per day; however, many places in the world are lower than that level so need a dietary supply. The objective of this study was to research the effect of feed Se supplementation on Se status in milk and mozzarella cheese quality. Thirty multiparous Holstein dairy cows (3 groups) with similar condition were raised in local dairy farm. First group of dairy cow was fed with selenium yeast (0.5 mg Se/kg dry matter), second group was fed with sodium selenite at the same Se concentration, third group without Se supply as control. After 2 mo feeding, milk samples were collected for Se analysis and cheese-making. Data were analyzed by one-way ANOVA using SAS 9.3. Results showed that the Se content in milk was increased to 47.9 μg/L by selenium yeast group, significantly higher than the 25.6 μg/L in sodium selenite group when both supplied with 0.5 mg Se/kg DM. The fat, casein and whey protein of Se-milk were seperated by ultracentrifuge and the Se content was determined by atomic absorption spectroscopy. The results were 9.82%, 45.56% and 44.62% respectively. When Se-enriched mozzarella cheese was made from high Se-milk and compared with control, no significant difference was found in composition or texture. But the functional properties (meltability, flowability and stretchability) were better in Se-cheese after 8 weeks storage. Additionally, the pH and a_w were lower in Se-cheese, leading to lower total plate count. The Se content increased more than 4 times in mozzarella cheese than milk, and additional Se was found in whey, hot water and brine collected during cheese-making. Organic and inorganic Se was found in Se-cheese after 8 weeks storage. Most of the Se-peptide produced during the storage was SeMet (215 ng/g) and SeCys (123 ng/g). The results of this study showed that the Se content in milk and cheese can be increased by dietary Se supplement, and the mozzarella cheese quality was not affected by feed Se supply.

Key Words: selenium status, Mozzarella cheese

W133 Microbiological characteristics and mineral content of probiotic low sodium Minas cheese with added arginine. Taissa Felicio, Marcia Cristina, Renata Raices, Luciana Nogueira, and Adriano Cruz*, *Federal Institute of Science and Technology of Rio de Janeiro (IFRJ), Rio de Janeiro, Brazil.*

The objective of the present study was to develop technology for the production of probiotic fresh Minas cheese with a reduced sodium content and the addition of arginine, and evaluate any changes in the quality parameters occurring throughout the shelf life. Gross composition and mineral content (moisture, protein, lipid, sodium, calcium and potassium). With the exception of the lipid content, differences were observed between the treatments during the storage period ($P > 0.05$) for all the parameters evaluated. Cheese QIII (50/50 NaCl/KCl reduction plus 1% w/w arginine) showed the highest moisture content (variation of 60 to 61.6% w/w, $P < 0.05$) and a progressive decrease in protein during storage (variation from 17.1 to 16.6% w/w, $P < 0.05$). With respect to the sodium and potassium levels, there was a progressive reduction in sodium in relation to the substitution level, that is, between the treatments, varying from 315 to 275 mg/100g (Qc, 100% NaCl) and from 193 to 215 mg/100g (QIII, 50/50 NaCl/KCl plus 1% arginine, $P > 0.05$). With respect to the calcium content, the addition of arginine resulted in a higher calcium content with an average value of 735.3 mg/100g (cheese QIII), whereas the value for the cheese containing only NaCl was 587.3 mg/100g ($P < 0.05$). Similarly, the concentration decreased throughout storage (variation from 591 to 566 mg/100g for cheese Qc with 100% NaCl, and from 744 to 660 mg/100g for QIII, with 50/50 NaCl/KCl added with arginine. The values observed were relevant and considerably lower than those reported on the labels of fresh Minas cheeses available on the Brazilian market, which show mean values of 437.4 mg/100g and in this context probiotic cheese with arginine seems an interesting option to functional cheese market.

Key Words: probiotic cheese, arginine, low sodium cheese

W134 Probiotic Minas Frescal cheese with *Lactobacillus casei* Zhang. Ramon Silva, Marcia Cristina, Luciana Nogueira, Renata Raices, and Adriano Cruz*, *Federal Institute of Science and Technology of Rio de Janeiro (IFRJ), Rio de Janeiro, Brazil.*

The addition of *Lactobacillus casei* Zhang in the manufacture of Minas Frescal cheese was investigated. Minas Frescal cheeses were produced by enzymatic coagulation and direct acidification, supplemented with probiotic bacteria (*L. casei* Zhang) and subjected to microbiological (probiotic and lactic bacteria counts) and physicochemical analysis (pH, proteolysis, lactic acid, and acetic acid level). Adequate *L. lactis* and *L. casei* Zhang counts were observed in both cheeses, and as previously discussed, the highest values were observed in all cheeses throughout the refrigerated storage (about 8 log cfu / g for *L. lactis*, ranging from 8.14 to 9.02 log cfu / g, $P < 0.05$, respectively. However, the addition of *L. casei* Zhang provided lower pH and high proteolysis indexes during storage (from 5.38 to 4.94 and 0.470 to 0.702, $P < 0.05$, respectively), and these changes were more significant in the cheese produced by enzymatic coagulation. In addition, with respect to the organic acids, regardless the treatment the addition of *L. casei* Zhang led to higher lactic acid and acetic acid levels (ranging from 1.75 to 2.98 and 0.45 to 0.84 μg/mL, $P < 0.05$). Consumer test reported improved overall liking for the control sample produced by direct acidification, (7.83, $P < 0.05$), while the cheeses containing *L. casei Zhang* presented lower values for all sensory attribute. The optimization of *L. casei Zhang* dosage during the manufacturing of probiotic Minas Cheese should be performed.

Key Words: probiotic cheese, *Lactobacillus casei* Zhang

W135 Effect of inulin and lactulose on characteristics of Iranian probiotic ultrafiltration feta cheese. Maryam Enteshari[1], Mahshid Azizi*[2], Bahram Jirsaraei[3], and Mohammadreza Dolatkhahnejad[4], *[1]Department of Food Science and Technology, Shahid Beheshti University of Medical Sciences, Tehran, Iran, [2]Islamic Azad University of Birjand, Chemical Engineering and Food Industries Department, Tehran, Iran, [3]Azad University of Varamin, Faculty of Agriculture, Department of Food Science and Technology, Tehran, Iran, [4]Islamic Azad University of Ayatollah Amoli, Food Industries and Scientific Engineering Department, Tehran, Iran.*

Nowadays, consumers' demands for foods with health effect, desirable organoleptic and mouth feel characteristics, low-caloric and low fat content have greatly increased. Meanwhile, consumption of synbiotic products (simultaneous presence of probiotic and prebiotic) has revealed functional properties. In this study, effects of prebiotic compounds including inulin (I), lactulose (L), and inulin-lactulose (IL) on physicochemical, sensorial and survival of *Lactobacillus casei* in ultrafiltration (UF) probiotic cheese in different storage days (1, 15, 30, 45 and 60) have been evaluated. Obtained results revealed that changes in pH values for all of cheese samples during storage were significant with a descending trend; the pH of IL sample declined significantly from initial value of 4.71 to 4.48 at the end of storage ($P < 0.05$). In other ways, amounts of acidity for all of cheese samples increased significantly during storage ($P < 0.05$); at the initial and final days of storage, the IL sample exhibited the highest acidity values (1.66 and 2.03 g/100g, respectively) while the L sample presented the lowest ones (0.98 and 1.23 g/100g, respectively). At the first and final days of storage time, the highest (65.11 and 64.8%, respectively) and lowest amounts of moisture content (63.27 and 63.12%, respectively) pertained to the C (control) and I samples, correspondingly. The cheese samples of I and IL presented the highest sensory scores. At the end of storage, the highest numbers of *Lactobacillus casei* were observed in the samples of I and L (in the range of 7.83–7.9 Log cfu/g) and the lowest one belonged to the C sample (6.63 Log cfu/g). Therefore, in this research the final synbiotic cheese which contained more than 10^7 cfu/g viable *Lactobacillus casei* at the end of storage, is being proposed as probiotic product and the inulin or lactulose prebiotic compounds in the single mixture (I or L samples) have protective effect on the survival of *Lactobacillus casei.*

Key Words: ultrafiltration cheese, probiotic, prebiotic

W136 Volatile compounds formation in Prato cheese. Lígia Dozena Domingos, Lilian Regina Barros Mariutti, Neura Bragagnolo, and Walkiria Hanada Viotto*, *University of Campinas (UNICAMP), Campinas, São Paulo, Brazil.*

Prato cheese is a washed curd and semi-hard cheese produced from pasteurized cows' milk acidified by a mesophilic starter containing citrate-positive bacteria, and matured for a minimum period of 25 d. Volatiles play an important role in flavor perception of cheese and they are result of compounds formed by glycolysis, citrate metabolism, proteolysis and lipolysis. The aim of this work was to evaluate the formation of volatile compounds in Prato cheese after 30 d of refrigerated storage at 12°C. The compounds were determined by gas chromatography-solid phase micro extraction coupled to a mass spectrometer detector (GC-SPME-MS). Two grams of a mixture of cheese sample and sodium phosphate saline solution (1:3, w/v) were incubated in a sealed 20 mL vial for 15 min at 40°C and after that, the DVB/CAR/PDMS fiber was exposed to the headspace for 30 min. The fiber was desorbed in the injector (splitless mode) at 250°C for 1 min. Compounds were separated in a RTX-Wax (30 m × 0.25 mm × 0.20 μm, Restek). Electron ionization source was set at 70 eV and 250°C. MS data were acquired in SCAN mode (*m/z* 35–350). Identification was carried out by comparison with mass spectra of authentic standards or Wiley 9 library and Kovats retention index. Volatile compounds found were organic acids ($C_{4:0}$ to $C_{10:0}$), esters (ethyl butyrate, ethyl hexanoate), ketone (2-pentanone, 2-heptanone, 2-undecanone), alcohols (ethanol, 1-pentanol, 1-butanol, 1-hexanol, 3-methyl-1-butanol, 1-heptanol, 1-octanol) and aldehydes (hexanal, heptanal, nonanal, decanal, benzaldehyde) as a result of cheese glycolysis, lipolysis and proteolysis. From the citrate metabolism, we found acetoin, 2,3-butanediol, 2-butanone and diacetyl, which is associated with characteristic butter flavor of Prato cheese.

Key Words: cheese ripening, GC-MS, flavor compound

W137 Consumer perception of reduced-fat fresh cheese in Brazil. Juliana Zara Brondi Mendes, Jorge Herman Behrens, and Walkiria Hanada Viotto*, *University of Campinas (UNICAMP), Campinas, São Paulo, Brazil.*

Minas Frescal, the most consumed reduced-fat cheese in Brazil, is a fresh and soft white cheese produced by the enzymatic coagulation of pasteurized milk, with high moisture content (>55%). It is industrially produced by 3 different processes that result in cheeses with different sensory characteristics, particularly texture. Cheeses manufactured by the traditional process (addition of starter) or direct acidification (by replacing the starter by lactic acid) have firmer texture than those produced by ultrafiltration which presents a gel texture, due to the incorporation of whey proteins. This work aimed to assess Brazilian consumers' perceptions regarding reduced-fat Minas Frescal cheese manufactured by three different technological processes (traditional, direct acidification, and ultrafiltration). A grocer's shop and a consumer research center in São Paulo, Brazil, served as settings for consumer test with 151 individuals. Respondents were characterized by a demographic questionnaire and purchasing habits. Conjoint analysis based on complete profile was conducted with eight different product concepts derived from a factorial design of relevant variables in local consumers' choices: texture (firm or soft), size of the pack (family or individual) and nutritional information (light or light + 40% less fat). The majority of consumers participating in the study were female, on high income and over 35 years old, and the main reason reported for consuming light cheeses was the concern for health. Conjoint Analysis revealed that texture (41.1%) was the most important attribute followed by portion size (36.2%) and nutritional information (22.7%). Consumers positively rated the firm texture, the individual portion, and the "light + 40% less fat." These results favor cheeses obtained by traditional process or direct acidification, due to their characteristic firmness that leads to higher purchase intention by the consumers. Findings of this study can assist cheese industries in adjusting process conditions, labels and packaging in order to enhance local consumers' willingness to purchase reduced fat cheese.

Key Words: fresh cheese, consumer, purchase intention

W138 Effect of myrrh essential oil as a highly effective antimicrobial agent in processed cheese spreads. A. G. Mohamed*, J. M. Kassem, and H. M. Abbas, *National Research Centre, Dokki, Giza, Egypt*

There is a new approach to prevent the proliferation of food microorganisms using of plant essential oils. *Commiphora myrrha* is considered as highly effective, natura, and safe antimicrobial. Therefore, the current study aimed to evaluate the effects of *Commiphora myrrha* on (1) pathogenic positive bacteria including *Listeria monocytogenes*, *Staphylococus aureus*, and *Bacillus cereus* as well as gram-negative bacteria including *Escherichia coli* O157:H7 and *Salmonella typhimurium*, and (2) the sensory properties of processed cheese spreads at 5 different levels of usage. Moreover, processed cheese spread (PCS) samples were prepared by using 5 different ratios of *Commiphora myrrha* essential oil at 0.2, 0.4, 0.6, 0.8, 1 w/w to evaluate its organoleptic acceptability. The PCSs was made by heating and mixing the ingredients at 85°C for 10 min. Gross chemical composition and some physical characteristics were estimated through 3 mo of storage at 5 ± 1°C. Oil separation, penetration,

melting point and color parameters were also determined through the storage period. Results showed that all tested microbes were susceptible to *Commiphora myrrha* at minimum inhibitory concentration of 2–5 µL of oil/mL. Moreover, results showed that using 0.2% (w/w) *Commiphora myrrha* essential oil gave satisfactory sensory properties. The appearance was shiny; gumminess and oil separation were absent. The overall preference of preferable ratio was "like very much" comparing to the other treatments. Color was more acceptable without significant differences ($P > 0.05$) and it spread well compared with control. The penetration values were 33.5, 32.0 and 31.2 mm versus 33.0, 30.5 and 26.5 mm for treated PCS versus control PCS ($P > 0.05$) when fresh, and after 1 mo and 3 mo of storage. Moreover, meltability 85.4, 81.6 and 80.0 mm versus 81.6, 80.5 and 78.7 mm for treated PCSs compared with control when fresh, and after 1 moand 3 mo of storage. *Commiphora myrrha* essential oil can be used successfully as antimicrobial agent during preparing of PCS with acceptable properties and satisfied sensory behavior.

Key Words: *Commiphora myrrha*, processed cheese spread, antimicrobial agent

W139 Effects of storage temperature and period on textural properties of cholesterol reduced and control Cheddar-type goat milk cheeses. Binod P. Gupta, Brittany I. Davis, Krishna P. Bastola*, Jolethia O. Jones, and Young W. Park, *Fort Valley State University, Fort Valley, GA.*

Consumption of fat and cholesterol reduced food products has been increasingly popular among health conscientious consumers due to its association with health problems including heart diseases and stroke. The objective of this study was to evaluate textural properties of cholesterol reduced (CR) and control (CC) caprine milk cheeses during storage. Three batches each of CR and CC Cheddar-type caprine milk cheeses were manufactured, and stored at 3 different temperatures (−18, 4 and 22°C) for 0, 3 and 6 mo. β-Cyclodextrin (β-CD) was used to remove cholesterol from milk and cream before manufacture of the CR cheeses. Textural properties of all experimental cheeses were evaluated using a texture analyzer (Model TA.XT2i, Texture Technology Corp., Scarsdale, NY). The pooled means (g force) of hardness, adhesiveness, resilience, cohesiveness, springiness, gumminess, and chewiness across batches, storage temperatures and periods of CC and CR cheeses were: 851.1, 2750.1; 11.4, 0.92; 19.3, 46.6; 0.45, 0.65; 69.9, 84.6; 388.3, 1976.2; 320.8, 1867.8, respectively. CR cheese had significantly ($P < 0.01$) higher hardness, resilience, cohesiveness, springiness, gumminess, and chewiness, but lower adhesiveness compared with CC counterparts. These results may account for the difference in moisture contents (55.3 and 50.8%) in CC and CR cheeses, respectively. For 3 main factors, cheese type was significant ($P < 0.01$) for all textural traits, while storage temperature and storage period were significant ($P < 0.05$ or 0.01) except for springiness and gumminess. For 2-way interactions, cheese type × storage temperature and cheese type × storage period were significant ($P < 0.05$ or 0.01) for most properties, whereas none of 3-way interactions were significant. It was concluded that textural properties of the experimental caprine cheeses were significantly affected by cheese type (cholesterol removal), followed by storage temperature and periods.

Key Words: goat milk cheese, cholesterol-reduced, texture

W140 Identification of crystalline entities in the rinds of white mold ripened cheese and smear ripened cheese with powder X-ray diffractometry. Gil F. Tansman*[1], Paul S. Kindstedt[1], and John M. Hughes[2], *[1]Department of Nutrition and Food Sciences, University of Vermont, Burlington, VT, [2]Department of Geology, University of Vermont, Burlington, VT.*

Curd softening in wheels of surface ripened cheese occurs radially from the surface toward the center and is the result of chemical changes including decalcification. It has been theorized that calcium is removed from the system by depositing as calcium phosphate crystals in and beneath the rind. Although researchers have observed calcium-containing crystals under the bloomy rind in several cheese varieties, no work has adequately determined the identity of the crystals. The present study was conducted to identify the crystals in bloomy rind (white mold ripened) cheeses and compare them to crystals that form in the smears of washed rind cheeses. Four varieties of Vermont soft ripened cheese were obtained from a commercial source; 2 of these were bloomy rind cheeses and 2 were washed rind cheeses. Powder X-ray diffraction (PXRD) patterns were generated for each cheese from fresh samples extracted from 1mm below the curd surface. Diffraction patterns were also generated from the smear material and surface hyphae scraped from the surfaces of washed rind and bloomy rind cheeses, respectively. The PXRD patterns revealed that small quantities of calcite ($CaCO_3$) form below the rinds of both cheese classes, but the diffraction patterns were very weak, due to the limited quantity of crystalline material present. Strong PXRD patterns from smear material revealed the presence of large concentrations of crystalline material. The smear from one cheese contained crystalline ikaite ($CaCO_3 \cdot 6H_2O$) and the other contained both ikaite and struvite ($NH_4MgPO_4 \cdot 6H_2O$). Powder diffractions from the bloomy hyphae produced very weak diffraction patterns with characteristic peaks of calcite, which may represent crystalline material that adhered to the hyphae from the cheese-hyphae interface.

Key Words: cheese, crystals, powder X-ray diffraction (PXRD)

W141 Characterization of single crystals in the rinds of white mold and smear ripened cheeses with single crystal X-ray diffractometry. Gil F. Tansman*[1], Paul S. Kindstedt[1], and John M. Hughes[2], *[1]Department of Nutrition and Food Sciences, University of Vermont, Burlington, VT, [2]Department of Geology, University of Vermont, Burlington, VT.*

Calcium-containing crystals that form in the rinds of soft surface-ripened cheeses are thought to contribute to cheese softening through the removal of calcium from the aqueous and colloidal states. Several researchers have observed crystals near the surface of bloomy rind cheeses but none have succeeded in identifying them. The present work was conducted in parallel with a powder X-ray diffraction (PXRD) study in which fresh cheese samples were analyzed for total crystalline composition. In contrast, this study used single crystal X-ray diffraction (SCXRD) and polarized light microscopy to identify individual crystals isolated from cheese rinds and surface smears to obtain chemical information about crystal structure and atomic uniformity. Four Vermont soft surface ripened cheeses were obtained from commercial sources; 2 of these cheeses were bloomy rind (white mold) varieties and 2 were smear ripened varieties. Samples from 1mm below the rinds of all 4 cheeses as well as scrapings of the washed rind surface smears were mounted on glass microscope slides and observed with a petrographic polarized light microscope. Rotation of the circular microscope stage allowed crystal extinction to be observed. Three distinct crystals were observed by comparing crystal morphologies and extinction variability. Two different crystals were observed in the smears (one smear exhibited only one of the crystals) and one entity was observed 1mm beneath the rind in all 4 cheeses. Nearly all crystals that had not been damaged in the mounting process exhibited uniform extinction indicating that they were single

crystals. Single crystals from the smears and from beneath the fungal bloom were isolated with a dissection needle and mounted on a goniometer head for analysis with a single crystal diffractometer. Structures for crystals in the smears were determined for ikaite ($CaCO_3 \cdot 6H_2O$) and struvite ($NH_4MgPO_4 \cdot 6H_2O$), and a crystal structure for calcite ($CaCO_3$) was determined from a bloomy rind crystal, thereby corroborating the results of the parallel PXRD study. This is the first observation of single crystals in cheese.

Key Words: cheese, crystal, single crystal x-ray diffraction (SCXRD)