238 Influence of dietary protein content and source on digestibility patterns and fecal osmolality in dogs differing in body size. J. Nery*[1], C. Tournier[2], V. Biourge[2], H. Dumon[1], and P. Nguyen[1], [1]*École Nationale Vétérinaire de Nantes*, *Nantes, France*, [2]*Royal Canin*, *Aimargues, France*.

Large breed dogs have frequently poorer fecal quality than smaller ones when given the same diet. Previous work indicated that this difference would be due, at least in part, to differences in fermentation and a higher osmolality in the hindgut chyme of large dogs. As we hypothesized that diet formulation could alter these differences, the aim of this study was to assess the effect of protein source and level on digestibility, fecal quality and osmolality in dogs differing in body size. 24 female dogs (2.75 to 32.10 kg BW) were used. Two diets were tested in a cross-over design. The main protein source of diet A was poultry and poultry by-products (ME=15.7 MJ/kg, CP=35.2%, fat=16.0%, TDF=7.7%, Na=3.45 and K=5.17mg/g DM) and the one of diet B was wheat gluten (ME=16.2 MJ/kg, CP=19.9%, fat=18.0%, TDF=9.0%, Na=3.85 and K=8.67mg/g DM). Fecal scores and DM, energy, fat, CP, ash, Na and K apparent digestibility coefficient (ADC) were determined. Fresh stools were analyzed for fecal osmolality. Data was statistically analyzed using ANOVA. Fecal score and moisture were higher in dogs fed on diet A and larger dogs had softer stools than smaller ones. ADC of DM, energy, fat, CP and ash was consistently higher for diet B. Differences among dogs' size were found to be higher for DM ($p \leq 0.0001$), energy ($p \leq 0.001$), CP ($p \leq 0.001$) and ash ($p \leq 0.05$) considering diet B. ADC of Na did not vary with dogs' size nor with diet while ADC of K varied both with dogs' size ($p \leq 0.05$) and diet ($p \leq 0.0001$), being higher for diet B. Osmolality was consistently higher for diet A ($p \leq 0.0001$) with differences also found between dogs' size ($p \leq 0.05$). This study showed that lower ADC of K and higher fecal osmolality would stimulate a lower water absorption in the hindgut promoting softer stools. A lower content and higher ADC of protein in the diet ameliorated fecal quality. Decreasing protein content in the diet and increasing its ADC would thus improve large dogs' feces quality.

Key Words: Dog, Protein, Digestibility

Dairy Foods: Cheese I

239 Chemical changes that predispose smoked cheddar cheese to calcium lactate crystallization. P. Rajbhandari*, J. Patel, E. Valentine, and P. S. Kindstedt, *University of Vermont*, *Burlington*.

We have observed a high incidence of calcium lactate surface crystals on naturally smoked Cheddar cheese in the retail marketplace. The objective of this study was to identify chemical changes that may occur during natural smoking which render Cheddar cheese more susceptible to calcium lactate crystal formation. Nine random weight (ca. 300 g) retail-packaged samples of smoked Cheddar cheese were obtained from a commercial manufacturer immediately after the samples were smoked for ca. 6 h at ca. 20°C in a commercial smokehouse. Three similarly sized samples that originated from the same 22-kg block of cheese and that were not smoked were also obtained. Within 2 d after smoking (0 wk), 3 smoked and 3 non-smoked samples were sectioned into 5 sub-samples at different depths representing 0-2, 2-4, 4-6, 6-8, and 8-10 mm from the cheese surface. Six additional smoked cheese samples were similarly sectioned at 4 wk and again at 10 wk of storage at 5°C. Sample sections were analyzed for moisture, pH, L(+) and D(-) lactate, and water soluble calcium. The effects of treatment (smoked, non-smoked), depth from cheese surface and their interactions were analyzed by ANOVA according to a repeated measures design with 2 within subjects variables. Smoked samples contained significantly lower moisture and lower pH, and higher lactate-in-moisture (LIM) and water-soluble calcium-in-moisture (WSCIM) than non-smoked samples at 0 wk. Smoked samples also contained significant gradients of moisture, pH, LIM and WSCIM, with lower moisture and pH, and higher LIM and WSCIM, occurring at the cheese surface. Gradients of moisture were still present in smoked samples at 4-and10 wk of storage. In contrast, the pH, LIM and WSC equilibrated and showed no gradients at 4 wk and10 wk. The results indicate that calcium and lactate in the serum phase of the cheese were elevated as a result of smoking, especially at the cheese surface immediately after smoking treatment, which presumably predisposed the smoked cheeses to increased susceptibility to calcium lactate surface crystallization.

Key Words: Cheddar Cheese, Calcium Lactate, Crystals

240 Nucleation and growth rates of calcium lactate crystals on smoked cheddar cheese. 1. Effect of storage temperature. J. Patel*, P. Rajbhandari, E. Valentine, and P. S. Kindstedt, *University of Vermont*, *Burlington*.

Previous studies have shown that storage temperature influences the formation of calcium lactate crystals on Cheddar cheese surfaces. However, the mechanisms by which crystallization is modulated by storage temperature are not completely understood. The objectives of this study were to evaluate the effect of storage temperature on: 1) the number of discrete visible crystals formed per unit of cheese surface area; 2) growth rate and shape of discrete crystals (as measured by radius, area and circularity); 3) percentage of total cheese surface area occupied by crystals. Three vacuum packaged random weight (ca. 300 g) retail samples of naturally smoked Cheddar cheese, produced from the same vat of cheese, were obtained from a retail source. The samples were cut parallel to the longitudinal axis at a depth of 10 mm from the 2 surfaces to give six 10-mm thick slabs, 4 of which were randomly assigned to 4 different storage temperatures: 1, 5, 10°C, and weekly cycling between 1 and 10°C. Samples were stored for 30 wk. Following the onset of visible surface crystals, digital photographs of surfaces were taken bi-weekly and evaluated by image analysis for number of discrete crystal regions and total surface area occupied by crystals. Also, specific discrete crystals were chosen and evaluated bi-weekly for radius, area and circularity. The entire experiment was conducted in duplicate. The effects of storage time and temperature on crystal number and total crystal area were evaluated by ANOVA according to a repeated measures design. Crystal number and total crystal area increased significantly during storage in a temperature-dependent manner as follows: 5°C<1°/10°C<10°C<1°C. However, storage temperature did not appear to have a major effect on the growth rates and shapes of the individual crystals that were chosen for analysis. The data indicated that storage temperature primarily affected the number of nucleation sites on the cheese surface that subsequently developed into discrete visible crystals.

Key Words: Cheddar Cheese, Calcium Lactate, Crystal

241 Nucleation and growth rates of calcium lactate crystals on smoked cheddar cheese. 2. Effect of packaging tightness. E. Valentine*, P. Rajbhandari, J. Patel, and P. S. Kindstedt, *University of Vermont*, *Burlington*.

Previous studies have shown that loose packaging favors the formation of calcium lactate crystals on the surface of Cheddar cheese. However, the mechanism by which crystallization is accelerated by loose packaging is not well understood. The objectives of this study were to evaluate the effect of packaging tightness on: 1) the number of discrete visible crystals formed per unit of cheese surface area; 2) growth rate and shape of discrete crystals (as measured by radius, area and circularity); 3) percentage of total cheese surface area occupied by crystals. Three vacuum packaged random weight (ca. 300 g) retail samples of naturally smoked Cheddar cheese, produced from the same vat of cheese, were obtained from a retail source. The samples were cut parallel to the longitudinal axis at a depth of 10 mm from the surface to give six 10-mm thick slabs, 3 of which were randomly assigned to 3 different levels of packaging tightness: 10 mbar (very tight), 70 mbar (slightly loose) and 960 mbar (very loose). Samples were stored at 1°C for 30 wk. Following the onset of visible surface crystals, digital photographs of the external smoked surfaces were taken bi-weekly and evaluated by image analysis for number of discrete crystal regions and total surface area occupied by crystals. Also, specific individual crystals were chosen and evaluated bi-weekly for radius, area and circularity. The entire experiment was conducted in duplicate. The effects of storage time and packaging tightness on crystal number and total crystal area were evaluated by ANOVA according to a repeated measures design. Loose packaging caused large, significant increases in the number of discrete crystals formed per unit of surface area and the total surface area occupied by crystals. However, packaging tightness did not appear to have a major effect on the growth rates or shapes of individual crystals that were chosen for analysis. The data indicate that loose packaging primarily increased the number of nucleation sites on the cheese surface that subsequently developed into discrete visible crystals.

Key Words: Cheddar Cheese, Calcium Lactate, Crystal

242 Nucleation and growth rates of calcium lactate crystals on smoked cheddar cheese. 3. Effect of cheese surface. J. Patel*, E. Valentine, P. Rajbhandari, and P. S. Kindstedt, *University of Vermont*, *Burlington*.

Previous studies have suggested that the surface characteristics of Cheddar cheese may affect the development of calcium lactate crystals. The surface of Cheddar cheese is altered considerably during natural smoking, which may contribute to the high incidence of crystallization observed in retail samples of smoked Cheddar. The objective of this study was to compare crystal nucleation and growth rates on the external surface (exposed to smoking) and a subsurface cut 10 mm below the external surface after smoking (not exposed to smoking) during storage under 4 different temperature conditions. Three vacuum packaged random weight (ca. 300g) retail samples of naturally smoked Cheddar cheese, produced from the same vat of cheese, were obtained from a retail source. The samples were cut parallel to the longitudinal axis at a depth of 10 mm from the 2 surfaces to give six 10-mm thick slabs, 4 of which were randomly assigned to 4 different storage temperatures: 1, 5, 10°C, and weekly cycling between 1 and 10°C. Samples were stored for 30 wk. Following the onset of visible surface crystals, digital photographs of the external surfaces and subsurfaces were taken bi-weekly and evaluated by image analysis for number of discrete crystal regions and total surface area occupied by crystals. Also, specific individual crystals were chosen and evaluated bi-weekly for radius, area and circularity. The entire experiment was conducted in duplicate. The effects of cheese surface, storage temperature and storage time on crystal number and total crystal area were evaluated by ANOVA according to a repeated measures design. The number of crystals and total surface area occupied by crystals were significantly higher at the external surface compared to the subsurface. Onset of visible crystals at the subsurface was delayed by ca. 20 wk compared to the external surface. However, the growth rates and shapes of the individual crystals selected did not appear to differ greatly. The data suggest that the surface of naturally smoked cheese is altered in a manner that favors nucleation site formation, increased crystal number and early onset.

Key Words: Cheddar Cheese, Calcium Lactate, Crystal

243 Influence of native pasture feeding time on conjugated linoleic acid content in Ragusano cheese. S. La Terra*[1], V. M. Marino[1], S. Carpino[1], M. Manenti[1], and G. Licitra[1,2], [1]*CoRFiLaC, Regione Siciliana*, *Ragusa, Italy*, [2]*D.A.C.P.A., Catania University*, *Catania, Italy*.

Ragusano PDO is an aged pasta filata cheese. It is a farmstead traditional cheese with unique aroma characteristics correlated to the environmental conditions and traditional cheese making technology. In 1996, Ragusano cheese has been designated PDO from the European Economic Community. It has been reported that dairy cows fed native pasture produce milk and consequently cheese with higher CLA content then dairy cows fed total mixed ration including forages with similar lipid content. The most representative CLA isomer is the cis-9, trans-11, and it generally constitutes 80%-90% of total CLA. The objective of this study was to determine the effect of Hyblean native pasture diet on conjugated linoleic acid (CLA) isomers content into Ragusano cheese at different ripening stages. The identification of CLA isomers in cheese was performed by silver ion high performance liquid chromatography. As expected, no variation in CLA content and isomers was observed in cheese samples analyzed at 90-120-210 days of ripening (913,80-925,32-901,09 ng/mg fat). Confirming previous data, the results clearly showed a direct relationship between native pasture and fat level of CLA in milk and cheeses produced from grazing animals. We also found that concentration of the total CLA and the cis-9, trans-11 increased with grazing time. We detected a double CLA level in cheeses produced with milk from cows grazing longer time (1288,33 ng/mg fat with 6 hours grazing vs 2459,39 ng/mg fat with 12 hours grazing). The quality of pasture is very important for the CLA content in fact the highest value of CLA occurs in native pasture than cultivate pasture. The high level of isomers of CLA could also be considered as an additional indicator for the authenticity of raw milk cheese from cows fed native pasture (P.D.O. marker).

Key Words: Conjugated Linoleic Acid, Cheese, Pasture

244 Novel approach for producing process cheese with reduced fat and reduced sodium content. L. E. Metzger and R. Kapoor*, *Midwest Dairy Foods Research Center*, *St. Paul, MN*.

The objective of the present study was to develop a novel commercially feasible approach for producing a process cheese with reduced fat and

reduced sodium content. The first objective of the present study was to develop a reduced fat reduced sodium Cheddar cheese (RFC) with modified manufacturing protocol to render a cheese that (after 1 wk of ripening) has a similar texture to full fat regular sodium Cheddar cheese. The second objective of the present study was to formulate a low-sodium-reduced-fat process cheese (LSRF) utilizing RFC and other ingredients so as to achieve a process cheese with a reduced fat and a reduced sodium content that has similar sensory and textural properties to commercial process cheeses. Results from the present project have indicated a successful production of LSRF. The final chemical properties of LSRF including its moisture, fat, sodium, and potassium were 50%, 10%, 280 mg/100g, and 1277 mg/100g respectively. Utilization of RFC as the cheese base facilitated in preventing LSRF from having a rubbery and crumbly texture typically associated with reduced fat process cheeses. One of the highlights of LSRF is the elimination of the bitter-metallic off-flavor that is typically found in reduced sodium products where potassium chloride is used as a salt substitute. Another highlight of LSRF is the enhanced cheese flavor notes that help in overcoming the typical bland flavor associated with low sodium and/or low fat cheeses. Along with RFC, that formed the major ingredient for LSRF, other ingredients such as tri-potassium citrate, maltodextrin, guar gum, and water provided LSRF with desirable texture. The ingredients that aided in enhancing the sensory properties of LSRF included a variety of cheese flavors, savory flavor-enhancer, potassium chloride based salt substitute, sugar, and lactic acid. The present approach was successful in producing a sliceable process cheese with a low sodium content (140 mg/serving) and up to 67 % reduced fat content without significantly affecting its sensory and textural properties.

245 Influence of starter bacteria and salt to moisture ratio on calcium lactate crystal formation. S. Agarwal*, J. R. Powers, S. Chen, B. G. Swanson, and S. Clark, *Washington State University*, *Pullman*.

Occurrence of L(+)-lactate crystals in hard cheeses continues to be an expense to the cheese industry. Salt tolerance of starter bacteria and salt to moisture ratio (S/M) in cheese dictates final pH of cheese, which can influence CLC formation. The research investigates the effects of (S/M) and starter bacteria on cheese pH and occurrence of CLC. A commercial starter was selected based on its sensitivity to S/M below and above 4.0 S/M. Cheddar cheese was made using either whole milk (3.25% protein, 3.85% fat, 4.74% lactose) or whole milk supplemented with ultrafiltered milk and cream (4.5% protein, 5.3% fat, 4.78% lactose). Calculated amounts of salt were added at milling (pH 5.40 ± 0.02) to obtain cheeses with low (3.5) and high (4.5) S/M. The cheeses were either vacuum packaged or gas flushed with CO2 and aged at 7.2oC for 3 months. Total and soluble calcium, lactic acid and pH were measured and CLC were observed in all cheeses for 3 months. Low and high salt concentrated milk cheeses (LSCMC and HSCMC), had 36% higher total calcium (1219 mg/100g and 1257 mg/100g cheese, respectively), than low and high salt whole milk cheeses (LSWMC and HSWMC; 908 mg/100g and 917 mg/100g of cheese, respectively). Soluble calcium was 29% higher in LSWMC and LSCMC (438 mg/100g and 454 mg/100g cheese, respectively) compared to HSWMC and HSCMC (339 mg/100g and 354 mg/100g cheese, respectively). Concentration of lactic acid in high salt cheeses ranged from 0.70 to 0.74%, while that in low salt cheeses ranged from 1.86 to 1.97% at the end of 3 months. CLC were observed in all low salt cheeses but highest intensity of CLC were observed in cheeses made with milk with high protein concentration and gas flushed packaging. These results confirm that occurrence of CLC formation is dependent on cheese milk concentration and cheese pH, which can be influenced not only by S/M but also by cheese microflora.

Key Words: Calcium Lactate Crystals, Starter Bacteria, Cheddar Cheese

246 Utilization of plant proteinase from Jack fruit *(Artocarpus integrifolis)* to accelerate the ripening of RAS cheese slurry as a functional food. E. E. El Tanboly* and M. A. El Hofi, *National Research Center*, *Dokki, Cairo, Egypt*.

The aim of the present work was to search for a novel plant proteinase enzyme from Jack fruit *(Artocarpus integrifolis)* as a source of protolytic enzymes to accelerate the ripening of Ras cheese slurry as a functional food. Plant proteinase would be natural products, which can be easily extracted at relatively low cost and no legal barriers. This enzyme was subjected to a purification scheme composed of ammonium sulfate fractionation followed by gel filtration on G-100 Sephadex column and purified proteinase properties was studied such as optimum incubation temperature and optimum incubation time, energy of activation, optimum pH, Thermal and pH stability, Michaelis-constant of (Km) values and Effect of metal ions and chemical reagents on enzyme. Crud extracted proeinase was used to accelerate ripening of Ras cheese slurry with concentration of 1 and 2 ml/100 g curd. Slurries were incubated at 37°C for 7 days. The results indicated that the ripening indices of slurries (SN/TN, tyrosin and tryptiphane) gradually increased as rate of enzyme increased and as ripening period progressed. Also, flavour of all slurries gradually improved during incubation period. At the end of incubation period slurry with 2 ml/100g curd had a high flavour scoring.

Key Words: Jack Fruit (*Artocarpus integrifolis*), Proteinase Enzyme, RAS Cheese Slurry

Egg and Meat Science and Muscle Biology - Livestock and Poultry: Meat Marination

247 Impact of functional ingredients on food safety. S. R. McKee*[1], C. Z. Alvarado[2], and J. W. Bowers[1], [1]*Auburn University*, *Auburn*, [2]*Texas Tech University*, *Lubbock*.

The most commonly used poultry marinades include salt and sodium tripolyphosphates which have been shown to increase meat yield, as well as improve color, water holding capacity, and texture. Recently, several poultry further processing facilities have begun using more acidic (pH ~ 4) type marinades such as sodium lactate (SL), sodium citrate (SC), and sodium diacetate (SD) (alone or in combination) to combat the growth of Listeria monocytogenes in further processed loaves. Since these acidic marinades currently used in turkey further processing have a low pH (~ 4) compared to the previously used salt and sodium tripolyphosphates (~ pH 9), these marinades may alter meat quality attributes. Current research suggest that sodium diacetate can inhibit the growth of LM during refrigerated storage, but the inclusion of this ingredient may alter the product's cohesiveness and