is likely to be critical in understanding differences between breeds in terms of productivity and disease resistance.

547 Current efforts in conservation of animal genetic diversity. H. Blackburn*[1] and D. Bixby[2], [1]*ARS-National Animal Germplasm Program*, *Ft. Collins, CO*, [2]*American Livestock Breeds Conservancy*, *Pittsboro, NC*.

Changing consumer demand, threat of disease, and contraction of genetic diversity drive the need to establish vibrant livestock conservation activities. For effective in-situ and ex-situ conservation strategies to function, dialog and synergetic action between public and private sectors must occur. This type of interaction exists and provides a basis for the operation of the National Animal Germplasm Program (NAGP), the American Livestock Breeds Conservancy (ALBC), other non-governmental organizations, and livestock breeders. Both NAGP and ALBC have increased the security of genetic diversity for a number of rare, minor and major livestock breeds in the US. In-situ security has improved with ALBC efforts to increase breed population size for 21% of the breeds in Critical/Threatened/Watch conditions between 1977 and 2005. These 16 breeds are now in the Recovering category. Since 1999, NAGP has developed an ex-situ collection of germplasm of approximately 250,000 units of semen, embryos and blood from 104 major, minor and rare breeds of cattle, sheep, goats and pigs. A key element in the public-private sector dialog is the collection, evaluation and utilization of information. Information such as, population census data, pedigrees, and number of breeders raising a breed have been collected and utilized to varying degrees. This information can serve as a basis for dialog and actions by the public and private sector. While some information is available for some breeds, the US has not fully engaged its capacity to measure genetic diversity by using molecular information. Such information would greatly add to the ability to assess diversity levels and contribute to decisions concerning conservation strategies. Additionally phenotypic assessments of many US rare and minor breeds are out of date and not relevant to populations today. This information void could dampen consumer demand for niche products as well as the effort to explore for unique genes and gene combinations. While conservation activities to date have strengthened genetic security, there are still significant knowledge, information and collection voids.

Key Words: Genetic diversity, Livestock conservation

Dairy Foods: Cheese II

548 Effect of mountain and sea level pasture on monoterpene composition in milk, curd and Ragusano cheese at 4 and 7 months of aging. S. Carpino*[1], T. Rapisarda[1], and G. Licitra[1,2], [1]*CoRFiLaC, Regione Siciliana*, *Ragusa, Italy*, [2]*D.A.C.P.A. Catania University*, *Catania, Italy*.

Dynamic headspace extraction (P&T) (Tekmar 3100) in combination with GC/MS using chiral stationary phase was employed to analyze the monoterpene composition of milk, curd (during cheese making), and cheese at 4 and 7 months aged from a farm of the Hyblean region sited on mountain level (ML) in Spring 2004. In farm ML we had three groups of Holstein cows (10 per group): group 1 fed TMR (ML0) no pasture; group 2 fed TMR supplemented with 30% DM of pasture (ML30), and group 3 fed TMR supplemented with 70% DM of pasture (ML70). Another farm sited on sea level (SL) was also tested. In this farm we selected only one group of Holstein cows, at similar lactation days and milk production level to the ML farm, fed TMR supplemented with 30% DM of pasture(SL30). The aim of this work was to study the impact of different level of pasture in the diet and the farm location on monoterpenes profile. A total of 16 milk and curd samples and 32 cheeses were analyzed. The general monoterpenes compostion detected in ML0 showed significant lower level compared with the ML30 and ML70 samples. The general terpene composition of samples obtained from mountain level (ML) farm was more abundant than the samples from sea level (SL). The monoterpene composition showed compounds like (-)-β-pinene, (+)-d-limonene, (+)-α-pinene in common between the ML30 and SL30 samples. It is important to note that some exclusive compounds were detected in ML samples: β-myrcene, (+)-sabinene, (-)-d-limonene, (+) δ-3-carene (ML), (+)-β-pinene, (+)-α-terpinolene, α-terpinene instead (-) Camphene was exclusively detected in the SL samples. These results indicate that the altitude may influence the type of pasture and the terpene profile that are transferred directly to the dairy products. The terpene composition, in fact, in dairy products depends on the type of pasture and therefore on the territory and its relative macroclimate. These compounds might be useful and used as valuable biomarkers for dairy products with Protected Designation of Origin.

Key Words: Ragusano cheese, Pasture, Monoterpene composition

549 Characterization of calcium lactate crystal growth on Cheddar cheese. P. Rajbhandari* and P. S. Kindstedt, *University of Vermont*, *Burlington*.

Previous research demonstrated that the total area collectively occupied by calcium lactate crystals on Cheddar cheese surfaces increased during storage in approximately linear manners but at different rates for different cheese samples. Evidence of substantial migration of calcium and lactate ions from cheese interior to surface during surface crystal growth was also observed. The objective of the present study was to characterize the growth of individual calcium lactate crystals on the surface of Cheddar cheese during refrigerated storage. A random weight (ca. 300g) retail sample of naturally smoked Cheddar cheese exhibiting white surface crystals was obtained from a commercial source. The sample was stored at 4°C for 30 weeks and a digital photograph was taken of one of the surfaces (ca. 55x120mm) at 3 wk intervals. The total area occupied by crystals on the photographed surface was measured at 3 wk intervals using image analysis. In addition, five small (ca. 0.3 mm radius) individual crystals on the first photographed surface were chosen for observation over the 30 wk period. The crystals were evaluated for area, radius and shape factor (circularity) every 3rd week using image analysis. The area collectively occupied by crystals on the photographed surface increased in a linear manner ($R^2=0.95$) from about 0.44% to 7.42% of the total surface area over the 30 wk period. Throughout this period, the shapes of the five individual crystals closely approximated perfect circles, and the area occupied by each of the five crystals increased in a near linear manner ($R^2=0.85-0.96$). The radii of each of the 5 crystals increased in a non-linear manner that conformed most closely to a second order

422

J. Anim. Sci. Vol. 84, Suppl. 1/J. Dairy Sci. Vol. 89, Suppl. 1

polynomial relationship (R^2=0.84-0.97). The rate of increase in crystal radii decreased over time as the crystals grew larger and occupied greater area. The data are consistent with the hypothesis that crystal growth occurs in 2 stages, the first governed primarily by the level of supersaturation of calcium lactate in the serum phase and the second by the rate of migration of calcium and lactate ions through the serum phase from the cheese interior to the surface.

550 Influence of emulsifying salts on functionality of sliced process cheese. N. Shirashoji*[1], T. Abe, K. Takahashi, and K. Iwatsuki, *Food Research & Development Laboratory, Morinaga Milk Industry Co., Kanagawa, Japan*.

Sliced process cheese (PC) is produced using a chill roll apparatus, which enables hot cheese to quickly cool as it revolves over a cold drum. Viscosity of hot melted cheese and tensile strength of the cooled cheese sheet are key characteristics in PC processing with a chill roll apparatus. Model pasteurized PC slices were prepared from Cheddar cheeses with 2.5% of various types of emulsifying salts (ES); trisodium citrate (TSC), disodium phosphate (DSP), tetrasodium pyrophosphate (TSPP) and sodium hexametaphosphate (SHMP). Cheese mixture was heated at 86°C using a Stephan cooker. Hot melted cheeses were poured into thin plastic bags and rolled to a thickness of 2 mm. Moisture content of model PC was 46%, which is common for pasteurized sliced PC in Japan. A modified Bostwick-type consistometer was used to determine the flowability of hot melted cheeses immediately after cooking. A burst test which is a large deformation test using a ball probe was performed to create a texture map of the PC slices made with different types of ES. Peelability of PC measured by a Yamaden creep meter was also evaluated as a textural property. Melting properties were analyzed using the Schreiber test. Water soluble protein as a % of total protein of cheese was measured. PC made with TSPP exhibited the lowest flow and meltability. There was no significant difference between TSC cheese and DSP cheese for flow and meltability. The texture map demonstrated that there were no significant differences in the burst stress of TSC and DSP cheeses. However, there were significant differences (P < .0001) in burst strain. TSPP and SHMP cheese had good peelability values, while TSC cheese and DSP cheese had poor peelability. There were large amounts of water soluble protein in TSC and DSP cheese (95% and 85%, respectively), while lower levels were observed in TSPP and SHMP cheeses. Water soluble protein levels may be related to the peelability of PC slices. This study indicated that different types of ES influenced the characteristics of PC that were important for use on a chill roll apparatus.

551 Quantitative analysis of cheese microstructure by scanning electron microscope images. M. Caccamo*[1], G. Impoco[2], L. Tuminello[1], and G. Licitra[1,3], *[1]CoRFiLaC, Regione Siciliana, Ragusa, Italy, [2]D.E.E.I. Trieste University, Trieste, Italy, [3]D.A.C.P.A., Catania University, Catania, Italy*.

Image analysis may represent a powerful tool to accurately quantify and rapidly process digital pictures from high-resolution images by scanning electron microscope (SEM). Nine traditional Sicilian cheese varieties, five pressed and four pasta filata, were observed by SEM to quantitatively characterize the porosity of their microstructure. Freeze-fracture sampling procedure according to McManus et al. (1993) was used. Ten sequential images, from two random fields of each specimen, were recorded at 500X and 1000X in order to obtain a more complete observation of the microstructure of each cheese. The obtained images were then analyzed using a Java language tool written as a plug-in of the ImageJ software. Gray-scale images were binarized using the threshold function, after having applied specific filters to remove noise, and alterations produced by the acquisition system. Images were firstly processed using a despeckle and then a Gaussian smoothing filter to remove noise. A further band-pass filter was applied to flatten lighting effects by cutting off high and low frequencies. A radius one erode filter before and a dilate-filter after thresholding were finally applied to regularize the pore shape and enhance borders. The processed images were then automatically measured to calculate microstructure porosity. No significant differences were found among the different magnitude factors. Pressed cheeses showed higher overall porosity (P < 0.01) than pasta filata cheeses, 0.15 vs. 0.24. Among the pressed cheeses it was observed a significant (P < 0.01) porosity variation ranging from 20.7% for Maiorchino, 16 mo aged hard cheese, to 29.8% for Fiore Sicano, 1 mo aged soft cheese. Similar porosity variation was observed on pasta filata cheeses, ranging from 11% for Provola dei Nebrodi, 3 mo aged semi-hard cheese, to 22% for Ragusano cheese, 9 mo aged. Three-dimensional analysis through X-ray microtomography could be used to further study without altering the internal microstructure of cheeses.

Key Words: Sicilian cheeses, SEM, Quantitative image analysis

552 Predicting curd moisture content, whey fat concentration and curd yield from near infrared light backscatter. C. C. Fagan[1], M. Leedy[2], M. Castillo*[2], F. A. Payne[2], C. P. O'Donnell[1], and D. J. O'Callaghan[3], *[1]University College Dublin School of Agriculture, Dublin, Ireland, [2]University of Kentucky, Lexington, [3]Moorepark Food Research Centre, Teagasc, Fermoy, Cork, Ireland*.

Cheese yield and quality are strongly affected by milk coagulation conditions, syneresis kinetics, and the extent of whey separation. Prediction of important cheese making performing parameters using inline measurements of milk coagulation and curd syneresis could play a decisive role in optimizing cheese processing efficiency and profits. The objective of this study was to determine if several frequently used cheese making efficiency metrics such as curd yield, whey fat concentration and curd moisture content could be predicted using optical parameters concurrently obtained during milk coagulation and syneresis from a large field of view (LFV) light backscatter sensor. A wide range of both coagulation and syneresis rates were tested at different levels of temperature and calcium chloride addition. Cutting time was an additional experimental factor in order to evaluate the impact of gel properties at cutting on cheese making efficiency. A three-level factorial, central composite rotatable design (α=1.682) with two start points and six replicates of the center point was chosen for this experiment. This experimental design allowed for the estimation of curvature and detection of levels at which the experimental factors will minimize/ maximize the efficiency metrics. The experiment was randomly replicated three times. Curd and whey samples were removed from the cheese vat at 10 min intervals during syneresis up to 85 min after cutting. Whey fat, total solids of both curd and whey, and curd yield were determined. Several optical parameters describing the rate of coagulation and/ or syneresis were found to be correlated to the cheese making metrics studied, allowing the prediction of curd yield, whey fat concentration and curd moisture content using light backscatter parameters from the LFV sensor. These results support the potential of the proposed technology for in-situ monitoring of coagulation and syneresis using a single sensor, which would result in improved cheese manufacture process control.

Key Words: Sensor, Light backscatter, Syneresis

553 Development and application of an image analysis method to measure and characterize calcium lactate crystals on uncolored Cheddar cheese. P. Rajbhandari* and P. S. Kindstedt, *University of Vermont, Burlington.*

Previous research demonstrated that image analysis can accurately and precisely measure the area occupied by calcium lactate crystals on the surface of smoked Cheddar cheese. Naturally smoked cheese is well suited for image analysis because the dark discolored smoked surface contrasts sharply with white calcium lactate crystals. Uncolored cheese is more problematical because of insufficient contrast between crystal and background. The objective of this study was to modify the previous image analysis method to measure calcium lactate crystals on uncolored Cheddar. Combinations of image contrast and sharpening settings of the digital camera and light options were systematically evaluated to identify settings that optimized the contrast between white crystals and the straw colored cheese background. Five replicate analyses of an uncolored cheese surface containing crystals were performed using the modified settings. The area occupied by crystals was determined to be $4.85 \pm 0.16\%$ of total surface area. The coefficient of variation of 3.26% was comparable to repeatability measurements previously reported for smoked Cheddar. The thresholding error (error of underestimation) for the 5 replicate measurements was 0.05%, which was less than that previously reported with smoked Cheddar. Thus, the efficacy of the revised image analysis method was comparable to that of the original method. The revised method was used to evaluate crystal growth on a smoked surface and a non-smoked (uncolored) surface, respectively, from the same Cheddar cheese sample that was stored for 10 wk under conditions chosen to accelerate crystal growth ($1°C$, loose packaging). The percentage of total surface area occupied by crystals increased in a non-linear manner from 0 to ca. 4.5% for both smoked and non-smoked surfaces. The pattern of area increase for both smoked and non-smoked surfaces conformed most closely to a second order polynomial relationship (R^2=0.97-0.98). Thus, crystal growth on uncolored cheese was effectively quantified using the revised image analysis method.

554 Computer vision analysis to monitor syneresis of cheese curd in a cheese vat. C. D. Everard*[1], C. P. O'Donnell[2], C. C. Fagan[2], D. J. O'Callaghan[1], M. Castillo[3], and F. A. Payne[3], [1]*Teagasc, Moorepark Food Research Centre, Fermoy, Co. Cork, Ireland,* [2]*University College Dublin, Dublin, Ireland,* [3]*University of Kentucky, Lexington.*

Syneresis, which follows the cutting of milk coagulum into cubes and is promoted by stirring, is the main phase separation process in cheese making. The extent of syneresis influences cheese quality as a result of its effect on moisture, mineral and lactose content of curd. The kinetics of curd syneresis is complex and there are no technologies currently available for monitoring it. The objective of this study was to investigate image analysis techniques for monitoring syneresis as a means of improving the control of curd moisture content in cheese making. The visual effect of syneresis during the curd agitation phase was monitored in a ten-litre cheese vat using a computer vision system in which curd and whey were distinguished by means of colour differences. The proposed monitoring system was evaluated within a wide range of curd syneresis kinetics using a completely randomized factorial design combining two levels of milk pH and two curd agitation speeds. Whey was found to have a filtering effect on light reflectance. As syneresis progressed, the reflected light became increasingly yellow in hue for circa 20 min., after cutting the gel. The changes leveled off after circa 30 min. Colour differences were found to be in proportion to percentage of whey expressed from the curd (R^2 = 0.99, P < 0.001). The results obtained show that a computer vision system could be used for monitoring syneresis. The proposed method would allow improving the control of the curd moisture content before ripening, which would decrease the production of down-graded ripened cheese.

Key Words: Computer vision analysis, Image analysis, Syneresis

International Animal Agriculture: Alternatives to Antibiotics if Feeding Ruminants for Optimal Production and Health

555 Differing objectives and key target microbes for manipulation of ruminal fermentation. R. J. Wallace*, *Rowett Research Institute, Bucksburn, Aberdeen, United Kingdom.*

The main objectives of manipulating ruminal fermentation have changed with time, and are different in different parts of the world. In North America, the emphasis remains on production efficiency, so avoidance of high-input problems like acidosis and high protein breakdown have greatest priority. In Europe, health issues, both in animals and man, which are associated with animal production have in recent years taken precedence over production efficiency. In Australasia, the environmental consequences of ruminant production, particularly methane formation, have received much recent attention. And in the developing world, priority is inevitably on making the most of scarce resources of low nutritive value. Paradoxically, the objectives of the different systems often have similar microorganisms as their target. For example, if methane formation were to be inhibited, not only would the emission of a greenhouse gas be decreased, but production efficiency would be increased. Thus, targetting methanogenic archaea

may have both environmental and efficiency benefits in both low- and high-input systems. Decreasing the bacteriolytic activity of ciliate protozoa would improve nitrogen retention in low-input systems scarce in N as well as enabling lower protein inputs into high-production systems that release environmentally damaging amounts of N to the environment. In terms of human health, minimising the biohydrogenation of unsaturated fatty acids to stearate by controlling key Butyrivibrio-related bacteria will, it is hoped, lead to ruminant products with a healthier fatty acid profile. Control of Escherichia coli is a high priority in all production systems. The means available to achieve the desired manipulations also vary geographically. Ionophores and antibiotics can still be used in North America but they are not permitted in Europe and are beyond the means of farmers in the developing world. Thus, natural products, including plants and their extracts, are increasingly being investigated throughout the world as potentially cheap, environmentally friendly means of manipulating ruminal fermentation.

Key Words: Manipulation, Rumen, Fermentation