calf vs. adult), antigen sensitization, and VitD on IFN and TNF secretion by bovine MNL. Heifers (VA, n=4) and 1-wk-old calves (VC, n=6) were vaccinated with BCG and boosted six weeks later. Ten weeks after primary vaccination, MNL from vaccinates and nonvaccinated, agematched calves (NVC, n=4) were evaluated in vitro for their capacity to produce IFN and TNF. Cells were nonstimulated (NS) or stimulated with mitogen (PWM) and antigen (PPD) in the presence of VitD (0, 1, and 10 nM). Cytokines in culture supernatants harvested at 20, 44, and 68 h were quantified by ELISA. Calf MNL produced (P<.10) more IFN and TNF than adult MNL in NS cultures, however, adult MNL produced more IFN (P <.05) than calf MNL in PWM stimulated cultures. Secretion of TNF in PWM stimulated cultures was unaffected (P=.36) by animal maturity. MNL from vaccinates (young and adult) produced more (P<.01) IFN than MNL from NVC, whereas, MNL from VC produced more TNF (P<.01) than MNL from VA or NV calves. VitD had no effect on cytokine concentrations in PPD stimulated cultures but in PWM stimulated cultures caused a dose-dependent decrease (P<.05) in IFN secretion and increase (P<.05) in TNF secretion. Incubation time affected (P<.05) cytokine concentrations. TNF levels were greatest at 20 and 44h, whereas IFN levels were greatest at 68h. These results indicate that age and antigen exposure affects cytokine secretion by bovine MNL and suggest that VitD can modulate secretion of both cytokines.

Key Words: Calf, Vitamin D, Cytokine

Graduate Paper Competition
CSAS Graduate Student Competition

1003 A bioeconomic model of the broiler chicken supply chain. M. J. Zuidhof*[1], R. J. Hudson[2], T. Joro[2], and J. J. R. Feddes[2], [1]*Alberta Agriculture, Food and Rural Development,* [2]*University of Alberta*.

A dynamic, deterministic bioeconomic model of the broiler supply chain has been developed with the objective of assisting the poultry industry with complex decisions. Because of biological variability and complex industry structure it is often difficult optimize decisions, which may be defined as decisions that yield maximum economic benefit to the supply chain. The model spans five sectors of the broiler supply chain: feed, hatching egg production, hatchery, broiler production, and processing. Biological productivity is based on the genetic potential of each strain of bird used in the model. The model operates on a daily time step, and accrues production and associated costs daily. In the broiler sector, production costs are accrued until the time of processing, after which costs are held constant. Prior to the onset of lay in the breeders, actual costs of chick production are undefined, so the model draws on a user supplied chick price. After 250 d of simulation, the model uses simulated chick cost, which drops with increasing breeder age as costs are spread over larger chick numbers. The cost reported on the last day of simulation represents the predicted costs if breeders are kept for the entire production cycle. The model is set to simulate 66 wk of production, a standard Alberta broiler breeder cycle length. Costs are reported in formats that are meaningful to each sector of the supply chain, and as the total cost per kg of meat produced by the supply chain. This is useful for analyses of the effects of specific supply chain management decisions, such as the choice of genetic strain, on costs at the level of each sector. This is important because although a decision may be optimal for the supply chain as a whole, it may not be optimal for all participants in the supply chain.

Key Words: Bioeconomic model, Supply chain, Optimization

1004 Exposing sows and their litters to recorded gruntings at fixed intervals: Effects on piglet growth, sow performance and nursing behavior. K Fisette*[1], J.P Laforest[1], S Robert[2], and C Farmer[2], [1]*Laval University, Quebec, Quebec, Canada.,* [2]*Agriculture and Agri-food Canada, Dairy and Swine R&D Centre, Lennoxville, Quebec, Canada*.

The impact of exposing lactating sows and their litters to recorded gruntings played at different intervals was studied. Yorshire × Landrace gilts were divided in three groups: 1) no playbacks (CTL, n=14), 2) 35-min intervals (M35, n=19), and 3) 40-min intervals (M40, n=16). Recordings were played from day 110 of gestation to day 27 of lactation. Nursing behavior (incidence of nursings without milk ejection (NWM) and nursing interval) was observed on days 6, 18 and 26 of lactation. Litters were uniformized to 10 ± 1 at 48 h postpartum, and piglets were weighed weekly. Sow feed intake was recorded throughout lactation. Sows were slaughtered on day 28 of lactation and their mammary glands were excised and weighed. There was a treatment × day interaction ($P \leq 0.05$) on nursing interval. On day 6 of lactation, the nursing interval tented to be lower in M40 than in CTL sows (33.2 ± 1.3 vs 37.2 ± 1.4 min; $P = 0.058$), while M35 did not differ from other treatments (34.9 ± 1.0 min; $P > 0.10$). Yet, the nursing interval was not affected by playbacks on days 18 (38.8 ± 0.9 min) and 26 (44.6 ± 0.9 min) of lactation in any of the treatments ($P > 0.10$). The incidence of NWM was greater on days 6 ($P = 0.015$) and 18 ($P = 0.02$) compared to day 26 of lactation in all groups, with mean values of 14.9 ± 1.4, 13.5 ± 1.3 and 9.0 ± 1.3 %, respectively. The percentage of NWM did not differ significantly ($P > 0.10$) between treatments. Yet, on day 6, M40 sows had a 29 % greater incidence of NWM than CTL sows. Piglet growth, sow feed intake and weight of the mammary glands were not affected by treatments ($P > 0.10$). In conclusion, exposing sows and their piglets to recorded gruntings played at 40-min intervals throughout lactation tended to reduce nursing interval in early lactation only, without affecting performance.

Key Words: Swine, Lactation, Nursing interval

1005 Anatomical measurements of the digestive tract and nutrient digestibility in the Asian Bear Cat (*Arctictis binturong*). C. Crapo*[1], A. Moresco[2], S. Hurley[1], T. Hanner[1], and C. Kadzere[1], [1]*North Carolina Agricultural & Technical State University,* [2]*Carnivore Preservation Trust*.

The Asian Bear Cat or binturong (*Arctictis binturong*) is classified as a carnivore in the Viverridae family and inhabits the South East Asian rainforest canopy. In its natural habitat the binturong has been observed to ingest a significant amount of fruits. Quantitative data regarding its dietary habits, nutrient digestibility, and utilization are limited. Thirty-five adult binturongs (4-16yrs) at the Carnivore Preservation Trust were included in a 50-day dietary study to include feed intake, nutrient excretion, nutrient digestibility, metabolic profiles, and physical examinations. The observed dental formula of the binturong was similar to that of a dog with three incisors (I) on the upper and lower jaw, one canine (C) on the upper and lower jaw, three premolars (PM) on the upper jaw and two on the lower jaw, and two molars (M) on the upper jaw and three molars on the lower jaw [2(I 3/3 C 1/1 PM 3/2 M 2/3) = 36; n=38] with incidence of variability between individual animals. The anatomy of the gastrointestinal tract (GIT) was examined during the necropsy of two, genetically unrelated, specimens. The average length of the small intestine was 130cm and the large intestine was 58cm, with an average total length of the GIT from the pyloric sphincter to the anus of only 188cm. This is slightly more than twice the average binturong#s body length, from the tip of the nose to the base of the tail, which is approximately 76cm. Necropsies revealed that the binturong have no cecum, resembling the GIT of the mink, a member of the Mustalidae family. However, the length of the binturong#s GIT is relatively shorter than that of the mink. The absence of the cecum may explain the observed expulsion of whole, and partially undigested fruit and vegetable matter in the feces. The characteristics of the GIT suggest that the binturong may be unable to digest and utilize fruits as efficiently as most monogastric animals with a cecum do. Considering that the binturong is known to ingest fruits in its natural habitat, it is possible that such fruits serve as a main source of water and that binturongs may require the ingestion of a large volume of fruits and other feeds to meet its nutritional requirements.

Key Words: *Arctictis binturong*, gastrointestinal anatomy, nutrition

1006 Expression of peroxisome proliferator-activated receptor (PPARγ) mRNA in adipose and muscle tissue of German Holstein and Charolais cattle. P. Huff*[1,2], J. Wegner[1], M. Ren[1], F. Lozeman[2], R. Weselake[2], and K. Ender[1], [1]*Research Institute for the Biology of Farm Animals, Dummerstorf Germany,* [2]*University of Lethbridge, Lethbridge, Alberta Canada.*

PPAR γ activity is known to regulate adipogenesis and lipid metabolism-related gene transcripts. The role, however, of PPAR γ in different adipose depots and muscle in secretion type (German Holstein) and accretion type (Charolais) cattle is still unclear. We used 20 animals for semi-quantitative RT-PCR to measure PPAR γ mRNA in subcutaneous (SC), perirenal (PR), omental (OM), and intramuscular (IM) adipose depots as well as longissimus muscle (LM). IM was dissected from muscle tissue in LM. No significant differences in PPAR γ were observed between different cattle breeds for each respective tissue, whereas between respective tissues, expression differed based on breed. In German Holstein no differences were observed between SC, PR, and OM depots while IM was lower ($P < 0.05$). The lowest ($P < 0.05$) expression was observed in LM. In Charolais OM PPAR γ was higher ($P < 0.05$) than SC and PR whereas IM and LM was the lowest ($P < 0.05$) also in this breed. To characterize the role of PPAR γ in bovine adipogenesis correlations were performed among PPAR γ, carcass characteristics, and adipogenesis-related genes. A low expression of muscle PPAR γ in German Holstein was correlated significantly ($P < 0.05$) with a high deposition of fat (SC, r = -.83; PR, r = -.86; and OM, r = -.89) and a high body weight (r = - .99). A high expression of PPAR γ in the IM depot was correlated with a high SC leptin receptor expression respectively in both German Holstein and Charolais (r = 0.94, r = 0.98). In Charolais a relationship was observed within the PPAR γ expression in the different depots. The high expression of PPAR γ in OM was correlated with a lower expression in SC (r = -.86) and IM (r = -.99). The different fat content of both cattle breeds may therefore be regulated by PPAR γ in a depot-specific manner.

Key Words: Adipose tissue, Muscle tissue, PPAR γ

1007 Effects of feeding blends of grains naturally-contaminated with *Fusarium* mycotoxins on growth, serum chemistry and hematology of starter pigs. H.V.L.N. Swamy*[1], T.K. Smith[1], E.J. MacDonald[2], H.J. Boermans[1], N.A. Karrow[1], and W.D. Woodward[1], [1]*University of Guelph, Guelph, ON, Canada,* [2]*University of Kuopio, Kuopio, Finland.*

An experiment was conducted to determine the effect of feeding blends of grains naturally-contaminated with *Fusarium* mycotoxins to starter pigs and to test the efficacy of a polymer extracted from yeast cell wall as a dietary treatment for *Fusarium* mycotoxicoses. A total of 150 starter pigs (initial weight of 9.3 kg) were fed 5 diets (6 pens of 5 pigs per diet) for 21 days. Diets included: (1) a control (0.3 ppm deoxynivalenol, DON and 26.68 ppm fusaric acid, FA), (2) a blend of 17% contaminated grains (2.2 ppm DON, 36.22 ppm FA), (3) a blend of 24.5% contaminated grains (2.9 ppm DON, 49.28 ppm FA), (4) a blend of 24.5% contaminated grains + 0.20% yeast cell wall polymer (MTB-100, Alltech Inc.) (2.8 ppm DON and 20.93 ppm FA), and (5) a pair-fed control group for comparison with group receiving 24.5% contaminated grains. The feeding of contaminated grains resulted in a significant linear decline in weight gain and feed consumption, and a linear increase in serum albumin to globulin ratio. Serum urea concentrations and gamma glutamyltransferase activity responded quadratically to the level of contamination. When compared to the pair-fed controls, serum concentrations of total protein and globulin were reduced in animals fed 24.5% contaminated grains. The dietary supplementation of the polymer significantly reduced gain to feed ratio in animals fed 24.5% contaminated grains. The feeding of contaminated grains did not alter serum immunoglobulin concentrations, hematology, peripheral blood differential leukocyte count, and the percentage of CD4/CD8 double positive, CD4 single positive, and CD8 single positive T-lymphocytes and B-lymphocytes. It was concluded that the feeding of grains naturally-contaminated with *Fusarium* mycotoxins can alter serum chemistry in starter pigs. The use of a pair-fed treatment group permitted the differentiation between the nutritional and systemic effects of *Fusarium* mycotoxins.

Key Words: Pigs, *Fusarium*, Deoxynivalenol

1008 Bacterial inoculant applied with or without hydrolytic enzymes to barley at harvest: Effects on fermentation and nutrient retention in silage. H. Zahiroddini*[1,2], J. Baah[1], and T.A. McAllister[1], [1]*Agriculture and Agri-Food Canada, Lethbridge, AB,* [2]*University of Tehran, Karaj, Iran.*

Including hydrolytic enzymes with a bacterial silage inoculant was proposed to accelerate fermentation and improve barley silage quality. This was investigated in a 2 × 2 factorial study using 96 laboratory-scale (3-L) silos. Whole barley forage was chopped, wilted to 35% DM and treated with water (control), inoculant (Agri-Sile®), enzyme mixture (primarily cellulase and amylase activities) or inoculant + enzymes (Silage-Pro®) prior to ensiling. Triplicate silos of each silage (denoted **C**, **I**, **E**, and **I+E**, respectively) were opened after 0.5, 1, 2, 3, 4, 7, 14 and 112 d for chemical and microbiological analyses. Silos were weighed after capping and before opening for estimation of DM loss. Inoculant increased the rate of decline of silage pH: **I** and **I+E** attained pH 4.0 by d 3, whereas **C** and **E** were at pH 4.2 and 4.25, respectively, at d 14. At d 112, soluble carbohydrate concentrations (g/kg DM) were lower ($P < 0.05$) in **I** and **I+E** (22.9 and 22.4, respectively) than in **C** (29.7) and **E** (32.7). Crude protein contents were higher ($P < 0.05$) in **I** and **I+E** (132 and 126 g/kg DM, respectively) compared with **C** and **E** (117 and 118 g/kg DM), and less NH_3-N (as % of total N) was present (3.74 and 4.49% in **I** and **I+E**, vs 7.50% in **C** and 6.68% in **E**; $P < 0.01$), suggesting reduced proteolysis with inoculant. At d 112, **C** and **E** had more ($P < 0.01$) acetate and total (TB) and lactic acid-producing (LAB) bacteria than did **I** or **I+E**. In both **C** and **E**, TB and LAB were present at ($\log_{10}$ cfu/g) 8.3 and 8.0, respectively; in both **I** and **I+E**, TB numbered ($\log_{10}$ cfu/g) 5.1 and LAB 4.9. Lactate concentrations (g/kg DM) were higher ($P < 0.05$) in **I+E** (106.5) than in **E** (91.9) or **C** (83.7), and intermediate (96.0) in **I**. Losses of DM during 112 d of ensiling were 8.1, 3.5, 4.3 and 1.2% in **C**, **E**, **I** and **I+E**, respectively. The bacterial inoculant clearly enhanced fermentation and retention of DM and nutrients in barley silage; the presence of enzymes may be beneficial.

Key Words: Barley Silage, Inoculants, Fermentation

1009 Predicting phytate content of Ontario soybean samples by near infrared reflectance spectroscopy. S.D. Leech*, E.V. Valdes, and C.F.M. de Lange, *University of Guelph, Guelph, Ontario.*

Phosphorus availability in swine and poultry feed ingredients is inversely related to the proportion of phosphorus present in the phytate form. An alternative to current phytate determination techniques is near infrared reflectance spectroscopy (NIRS). The objective of this study was to evaluate NIRS as a rapid and accurate means to determine the phytate content in Ontario soybean samples. A total of 108 samples were collected representing 17 varieties and 13 growing locations over a two year period. Analysis for phytate content was conducted according to AOAC procedures and checked for repeatability and accuracy using sodium phytate standards. Phytate content (%) averaged 1.07 (SD 0.20) in 1999 and 1.27 (SD 0.26) in 2000. Individual calibrations were developed based on the year of collection (1999, 2000 and 1999&2000). Samples were selected for calibration based on phytate content or reflectance profiles while remaining samples were used for validation. Various calibration procedures were evaluated based on mathematical treatment of reflectance data (smoothing, scatter correction and use of derivatives) and statistical analysis (principal components combined with repeated sampling and cross validation - MPLS - or stepwise regression). The best fit, based on the standard error of cross-validation (SECV) and the standard error of prediction (SEP), was obtained when using MPLS with a second derivative math treatment and no scatter correction. Model statistics for 1999 samples (SECV=0.13; SEP=0.13) and 2000 samples (SECV=0.16; SEP=0.09) indicate the ability of NIRS to predict phytate content. Calibrations developed for 1999&2000 samples produced low SECV (<0.13) with higher SEP (>0.17), however the combination of both years produced the highest SD to SECV ratio (1.9) indicating a stronger equation. Results confirm that with a larger number of samples representing the entire range of phytate content NIRS can be used as a rapid method to predict phytate content in soybeans.

Key Words: Phosphorus, Phytate, Soybeans, Near infrared reflectance spectroscopy

1010 Degradation of cell wall polysaccharides by a combination of carbohydrase enzymes: In vitro and in vivo studies. X. F. Meng*, F. O. Omogbenigun, C. M. Nyachoti, and B. A. Slominski, *Department of Animal Science, University of Manitoba, Winnipeg, MB, Canada*.

Non-starch polysaccharides (NSP) in feedstuffs of plant origin affect nutrient utilization by non-ruminant animals mainly due to the antinutritive effects associated with water-soluble and viscous polysaccharides and nutrient encapsulating effect of the cell walls. In vitro incubation studies were carried out to determine if various carbohydrase enzyme complexes contained appropriate activities to target NSP of soybean meal, canola meal and peas. A more pronounced depolymerization of the NSP was achieved when selected enzyme preparations were used in concert. When compared to the control (non-enzyme) treatment, the degree of NSP hydrolysis and/or disruption of the cell wall structure averaged 19.5, 34.0 and 24.7% for soybean, canola meal and peas, respectively. Effective enzyme combinations were studied further in digestibility trials with poultry and swine. In the broiler chicken assay, the digestibility of NSP increased from 2.0 to 16.9% in birds fed enzyme supplemented soybean/canola meal/peas/wheat based-diet. In a subsequent, 3-wk growth performance trial, an improvement ($P<0.05$) in body weight gain (646 vs 682g) and feed conversion ratio (1.43 vs 1.39) was noted with enzyme supplementation. In adult roosters fed the coarsely ground canola seed, the digestibility of NSP increased from 11.1 to 30.1% for the enzyme supplemented sample and resulted in an improvement ($P<0.05$) in energy utilization (4133 vs 4735 kcal/kg DM). In the pig trial, ileal NSP digestibility averaged 10.2 and 26.0% for the control and enzyme supplemented wheat/soybean/canola meal/peas-based diets, respectively. This was followed by the same magnitude of difference ($P<0.001$) in dry matter digestibility (62.5 vs 71.3%). Only a trend towards improved ADG (231 vs 251g; $P=0.145$) and FCE (1.87 vs 1.66; $P=0.08$) with enzyme supplementation was noted.

Key Words: Non-starch polysaccharides, Cabohydrase enzyme, Non-ruminants

Dairy Foods
Cheese and Sensory

1011 A survey of California specialty cheese consumers' opinions and shopping habits. B. A. Reed*[1] and C. M. Bruhn[2], [1] *University of California Cooperative Extension, Glenn County,* [2] *Center for Consumer Research, University of California, Davis*.

To improve marketing effectiveness for small-scale farmstead cheese producers, the shopping habits and opinions of specialty cheese consumers were gathered by telephone and focus group interviews in three locations. Volunteers were recruited from specialty cheese counters in upscale grocery stores in Northern California. Of the 47 consumers surveyed by telephone, 9% purchased specialty cheeses several times per week, another 38% purchased cheeses weekly. Specialty cheese purchases represented 75% of all cheese purchases for 48% of those interviewed. Of those interviewed, 26% bought more than 0.45 kg of cheese in any given purchase. All of the consumers (100%) reported eating cow's milk, 96% ate goat or sheep milk cheese, 98% ate aged hard cheese, 94% ate veined cheeses, 81% ate soft surface-ripened cheeses. Respondents purchased European specialty cheeses most frequently (57%) followed by California specialty cheese (32%). Thirty four of the volunteers interviewed by telephone also participated in focus groups. Buying locally produced foods was very important to 38% of focus group participants, while buying foods directly from family-owned farms was rated as very important by 15% of participants. Buying foods that have potential health benefits was rated as very important by 53% of participants. Although specialty cheese consumers considered themselves food experimenters and not afraid to sample new cheeses, generally they would not purchase a new cheese without tasting it first. Consumers relied heavily on specialty grocery staff recommendations for guidance in cheese selection and valued food descriptions that included origin, flavor, texture, recommended uses and food and wine pairings. When shopping, consumers appreciated unlimited tasting opportunities and did not want to feel hurried when making a cheese selection. Few consumers mentioned price when discussing purchase decision criteria unless making purchases for a family. Consumers place a high value on perceived freshness and quality. Cheese makers should take time to do in-store sampling, distribute their product to stores that place a high emphasis on customer service and be sure the cheese sales staff are well educated about the unique properties of their product.

Key Words: Specialty cheese, Consumers, Focus groups

1012 Cheese making properties of milk enriched with β-casein. Sylvie Haché* and Daniel St-Gelais, *Food Research and Development Centre, Agriculture and Agri-Food Canada, St-Hyacinthe, Quebec*.

In this study, the impacts of milk enriched with β-casein on bacterial growth, coagulation properties and composition of Cheddar cheese like-product were investigated. Enriched milk was adjusted to 2.67 (EM1), 2.86 (EM2), or 3.04% (EM3) of casein with a β-casein powder. Fresh milk (2.49% casein) was used as a control (CM). The casein to fat ratio for cheese milks was adjusted to 0.67, 0.69, 0.72 and 0.74, respectively with fresh cream. The evolution of population of proteolytic (PRT^+) and non-proteotylic (PRT^-) strain of lactococci in all cheese milks was determined on M17 agar. Coagulation properties were determined with a formagraph and by using a turbidity method. Cheeses obtained from control and enriched milks were analysed for moisture, protein, fat and ash. During cheese ripening, the evolutions of proteolysis (WSN) and firmness were determined. The experiment was replicated six times. A factorial design was used to compare different treatments. Results indicated that the growth of lactococci was not affected by β-casein concentration in cheese milks. Rennet curd formation was affected by the β-casein in enriched milks. Coagulation time increased with β-casein concentration. The moisture (41.1%) and ash (3.4%) contents were higher, whereas the protein content (23.2%) was lower in control cheese than in cheeses enriched with β-casein (39.7, 3.0 and 24.6%, respectively). In addition cheese yields increased with β-casein concentration. During cheese ripening, the evolution of proteolysis was similar for all cheeses. Firmness for all cheeses decreased continuously but was lower in control cheese. Cheese could be produced from milk enriched with β-casein. However, cheese production must be modified.

Key Words: Enriched milk, Cheese, β-casein

1013 Impacts of salt on the composition, proteolysis and functional properties of Mozzarella cheese. Annie Caron*[1], Daniel St-Gelais[1], and Pierre Audet[2], [1] *Food Research and Development Centre, Agriculture and Agri-Food Canada, St-Hyacinthe, Quebec,* [2] *Agropur, Granby, Canada*.

In this study, the impacts of different salting procedures during Mozzarella cheese production on the composition, distribution of salt and moisture, proteolysis, and some functional properties were investigated. For the control Mozzarella (CM) cheese the fresh curd after stretching and forming was immersed in a salt brine solution (19% NaCl; 10 h at 4C). The experimental Mozzarella (EM) cheese was salted on curd before stretching (1.2% NaCl), during stretching (5% NaCl) and finally in brining (19% NaCl; 30 min at 4C). Mozzarella cheeses were produced from milk enriched to 3.7% of total proteins with an UF milk retentate. The protein to fat ratio was adjusted to 1.33. All cheeses were stored at 6C for 14 d. Cheeses were analyzed for moisture, proteins, fat, ashes, calcium, salt, and residual rennet (RR) activity. The distribution of salt, moisture, proteolysis, melted cheese firmness and spreading cheese property was determined from surface (S) to centre (C). The experiment was replicated four times. The moisture (46.5%), salt (1.0%) and ash (2.9%) contents were lower, whereas the protein (26.6%), fat (21.9%), calcium (0.79%) contents were higher in CM than in EM cheeses (48.5, 1.5, 3.2, 25.1, 21.3 and 0.62%, respectively). The RR activity was higher in CM (8.0%) than in EM cheeses (6.6%). In general, the protein and fat losses in whey and in water during stretching were higher for EM than for CM cheeses. During storage, the salt and moisture distribution from surface to centre was more uniform in EM than in CM cheeses. The proteolysis was higher in CM than in EM cheeses, mainly on surface cheeses. The melted cheese firmness was higher, whereas the spreading properties were lower in CM than in EM cheeses. By modifying the