DAIRY FOODS: **TECHNICAL SESSION 3: FLUID MILK**

1019 (W073) Interaction of bovine and caprine milk α-caseins with tea polyphenols.
A. Mora-Gutierrez*, and R. Attaie, *Prairie View A&M University, Prairie View, TX.*

Tea (*Camellia sinensis*) is one of the most commonly consumed beverages. The anticarcinogenic properties of the many phenolic compounds of tea, including catechins, have been shown to inhibit tumor formation in rats. The anticarcinogenic properties of these phenolic compounds have been attributed to their antioxidant activity. However, the antioxidant activity of tea polyphenols may be affected when adding milk to tea. In this work, 7.6 mg/L bovine or caprine milk α-casein and 7.7 μM tea polyphenols (catechin, epicatechin, epicatechingallate, epigallocatechingallate, epigallocatechin and theaflavin) were added to an emulsion of linoleic acid (40 mM) prepared using a borate buffer (0.1 M, pH 8.5) and containing 0.1 M of sodium dodecyl sulfate. Interaction of bovine and caprine milk α-caseins with tea polyphenols in sodium dodecyl sulfate micelles was studied by a lipid peroxidation method. It was found that the antioxidant activities of the smaller catechins (catechin, epicatechin and epigallotocatechin) were higher in the presence of bovine and caprine milk α-caseins. The antioxidant capacity of epigallocatechin was greatly enhanced ($P < 0.05$) by milk α-casein (21.3% by bovine milk α-casein and 25.2% by caprine milk α-casein). The larger and bulkier polyphenols from tea (epicatechingallate, epigallocatechingallate, and theaflavin) did not significantly increase ($P < 0.05$) the lipids protecting effect. These results suggest that bovine and caprine milk α-caseins have the potentials to be used as natural ingredients to increase the antioxidant activity of tea polyphenols.

Key Words: bovine and caprine milks, α-casein, antioxidant activity, tea polyphenols

1020 (W074) Comparison of Jersey And Holstein-Friesian milk composition and coagulation properties.
J. H. Bland*, C. C. Fagan, and A. S. Grandison, *University of Reading, UK.*

Holstein-Frisian milk is increasingly blended with Jersey milk by cheesemakers to improve cheese yield. However, to date, no study has investigated the impact of blending on milk composition and properties. The objective of this study was to compare the composition and milk coagulation properties of Jersey and Holstein-Friesian milk produced in the United Kingdom. In addition, the effect of blending the two types of milk at different ratios (0 to 100% Jersey milk in Holstein-Friesian at 10% intervals), was evaluated. This knowledge could assist cheesemakers in optimising the blending process. Raw bulk milk composition from both breeds was measured every 3 mo over a year ($n = 55$). Significant variations in fat, protein, fat to protein ratio, casein, casein to protein ratio, fat globule size (D(4.3), D(0.5) and span), casein micelle size and titratable acidity were observed ($P < 0.05$). However, no significant difference in lactose, urea, somatic cell count, calcium ions, fat globule surface area mean particles D(3.2) and pH were seen. Blending the milks resulted in a linear trend for all significant variables with the exception of the fat globule volume mean diameter D(4.3) and casein micelle size which followed a quadratic trend ($P < 0.05$), which is believed to be due to change in the mineral balance. Coagulation properties were measured using a C-VOR controlled stress rheometer using raw milk at natural pH. Rennet Coagulation Time (RCT) (min) was defined as at the time at which a firmness of 0.5 Pa was attained, Curd Firmness (CF) (Pa) was taken 10 min after coagulation and Curd Firming Rate (CFR) (Pa min^{-1}) was calculated from the time for the gel to firm from 0.5 Pa to 2 Pa. Mean RCT of Holstein-Friesian was 58.7 min compared to 24.0 min for Jersey milk ($P < 0.001$). CF was 2.01Pa compared to 12.50 Pa and CFR 0.14 Pa min^{-1} compared to 0.49 Pa min^{-1} respectively ($P < 0.001$). CFR increased linearly with increase percentage of Jersey milk ($R^2 = 0.940$, $P = 0.003$) whereas RCT and CF followed a quadratic trend with increased percentage of Jersey milk ($R^2 = 0.9903$, $P = 0.007$ and $R^2 = 0.9965$, $P = 0.001$, respectively). This could be linked to the nonlinear trend found in fat globule volume mean diameter D(4.3) and casein micelle size. This study demonstrates that Jersey milk composition and coagulation properties are more suited for cheese making than Holstein-Friesian and additionally indicated that blending the two milk types gave beneficial synergistic effects for cheese.

Key Words: milk composition, milk coagulation, breed

1021 (W075) Light exposure affects milk acceptability and emotional response of college students.
A. M. Walsh, H. Potts*, and S. Duncan, *Virginia Tech, Blacksburg.*

Off flavors in fluid milk result from light exposure due to poor light-blocking characteristics of packaging materials. Even short periods of light exposure cause light-induced oxidation leading to noticeable differences in flavor. There is no direct evidence that light-induced oxidation affects milk acceptability. In this study, effects of fluorescent light exposure (2000 lux) on fluid 2% milk for periods of 8 and 168 h (7 d; 4°C) were determined on oxidative stability of milk, consumer acceptability of the product, and the resulting emotional response from the sensory experience. Oxidative stability was measured by thiobarbituric reactive substances (TBARS) and riboflavin (Rb) assays. Consumer ($n = 53$) acceptability of the product was reduced, as measured with a 9-point hedonic scale and a check-all-that-apply emotional response scorecard. TBARS assays showed significant in-

creases in oxidation by-products by 168 h (P = 0.006). Rb decreased significantly, with 71% loss by 168 h. Although there was no significant chemical evidence of oxidation by 8 h of light exposure, hedonic scores decreased significantly from 7.20 (like moderately) to 5.85 (below like slightly) (P = 0.008). Acceptability decreased severely by 168 h of light exposure (P = 2.15 E-10) with light-exposed milk scoring only a 3.46 (between dislike moderately to dislike slightly). Light-protected milk maintained a score of 7.0 over the 7 d of refrigerated storage. Emotion term selection reflected the acceptability change; across all milk samples the terms calm, content, good and satisfied were shared ($\geq$ 20% frequency of the term used and < 8% difference in percent frequency between samples compared). Unique terms for 'liked' samples (hedonic score: 6 to 9) included friendly, good-natured, happy, interested, peaceful, pleasant, pleased, quiet, safe, warm, and whole. However, 'disliked' samples (hedonic score: 1 to 4; mostly light-exposed milk samples) exclusively shared the term disgusted. Milk that is protected from light maintains a high quality flavor with positive emotional responses whereas the influence of light degradation causes negative sensory and emotional responses. The emotional and flavor acceptability of milk is particularly important in the 18- to 25-yr-old population focused on in this study. This population is establishing independent selection, purchasing habits, and consumption of products that influence future health and well-being. In the tested population, only 24% reported consuming any milk (whole, 2%, 1%, skim) more than once daily. The selection of milk packaging that protects milk nutrients and flavor quality is important consideration for increasing milk consumption.

Key Words: milk, emotion, oxidation

1022 (W076) Fatty acid compositions of low-fat goat milk ice creams formulated with commercial ice cream mix and 3 different levels of caprine milk fat. C. E. McGhee, B. P. Gupta*, and Y. W. Park, *Fort Valley State University, Fort Valley, GA.*

Low-fat ice cream has been a popular frozen dairy food among the consumers due mainly to health concerns. However, scientific research on nutritional quality of caprine milk ice cream has been very scarce. The objective of this study was to determine fatty acid compositions of three types of low-fat goat milk ice creams. Three batches of three different low-fat caprine milk ice creams were manufactured using skim (0.46%; SIC), 2.0% (2IC) and whole (3.65%; WIC) goat milk by addition of a commercial ice cream mix (0.25% fat) in fluid goat milk. The soft-serve goat ice creams were made using Sani Serv ice cream machine (A5223P, Mooresville, IN), and all experimental fresh ice creams were stored at -18°C in a freezer for 0, 2, 4, and 8 wk. Fatty acids compositions of all experimental ice cream samples were analyzed using a GC–MS (Thermo Electronic TRACE GC Ultra, Austin, TX) equipped with an automatic sampler (Thermo Electronic AS-3000) and a fused silica capillary column (0.25 mm i.d. x 0.25μm × 60 m; SP-2380 Supelco, Bellefonte, PA). The results showed that concentrations of fatty acids C4:0, C6:0, C8:0, C12:0, C14:0, C16:0, C16:1, C18:0, C18:1, C18:3, C24:0 in the ice creams were significantly (P < 0.05 or 0.01) affected by the three different levels of fat treatments, while those of C10:0, C14:1, C18:2, C20:0, C22:0 acids were not influenced by the fat treatment. The C12:0, C16:0 and C18:1 acids were the most abundant fatty acids in the experimental goat ice creams, while C12:0 (lauric acid) revealed the highest concentration among all 16 fatty acids. There were no differences in levels of individual fatty acid between storage periods, where the same trend of storage effect occurred in all 16 fatty acids. The fat level x storage interaction effects were also not significant on fatty acid contents of all three goat ice creams. It was concluded that the highest content of lauric acid among all fatty acids was probably due to the existence of coconut oil in the commercial ice cream mix, which was used in the manufacture of goat milk ice creams in this study.

Key Words: goat milk, ice cream, fatty acids

1023 (W077) Application of non-nutritive natural sweeteners to skim chocolate milk. *X*. E. Li*, K. Lopetcharat, and M. Drake, *Southeast Dairy Foods Research Center, NCSU, Raleigh, NC.*

The additional sugar content of chocolate milk has raised health concerns, and artificial non-nutritive sweeteners have been used to reduce sugar and calories. However, artificial sweeteners lack appeal to parents for purchase of chocolate milk for their children. Natural non-nutritive sweeteners may be viable alternatives to sweeten chocolate milk. The objective of this study was to evaluate stevia or monk fruit extract as the sole or partial sweetener source for skim chocolate milk. Magnitude estimation scaling (MES) with 14 trained panelists was used to create power function curves for the sweet taste of stevia and monk fruit extract in water and skim chocolate milk. The iso-sweetness of 150 mM sucrose chocolate milk, the lowest acceptable sweetness level for young adult consumers in a previous study, from stevia or monk fruit extract were calculated and confirmed by a 2-alternative forced choice (AFC) test with 25 panelists. Due to other taste and flavor attributes of the two natural non-nutritive sweeteners, iso-sweetness from a mixture of sucrose and natural non-nutritive sweetener were also investigated. Chocolate milks (sweetened with sucrose, stevia, monk fruit, stevia:sucrose blend, or monk fruit:sucrose blend) were manufactured and evaluated by young adult consumers (n = 120) for overall and sweet taste liking. Chocolate milks that were sweetened by natural non-nutritive sweeteners alone received lower liking scores compared to chocolate milks sweetened by sucrose or sucrose:non-nutritive sweetener blends (P < 0.05). The results demonstrate that natural non-nutritive sweeteners can be successfully applied in choco-

late milks with no change in liking from sucrose when applied as blends replacing up to 50% of sucrose.

Key Words: chocolate milk, flavor, sugar reduction

1024 (W078) Cross-linking of milk proteins can reduce its susceptibility to plasmin-induced hydrolysis.

H. Bhatt*[1,2], A. Cucheval[2], C. Coker[2], H. G. Patel[3], A. Carr[1], and R. Bennett[1], *[1]Massey University, Palmerston North, New Zealand, [2]Fonterra Research & Development Centre, Palmerston North, New Zealand, [3]South Dakota State University, Brookings.*

Plasmin-induced proteolysis is a major problem in milk and dairy beverages and must be controlled, as it leads to flavor (bitterness) and texture (gelation, sedimentation) defects. Plasmin cleaves proteins at the carboxyl site of lysine-X and arginine-X bonds with a preference for the lysine-X bond. We therefore hypothesized that cross-linking of milk proteins and modification of lysine residues through transglutamination and the Maillard reaction would reduce the susceptibility of milk proteins to the action of plasmin. Lysine residues on the β-casein backbone were cross-linked with glutamyl residues to different extents by transglutamination and lysine-sugar-lysine cross-linking was achieved through the Maillard reaction. The modified systems were then hydrolyzed by plasmin. The extents of cross-linking and the hydrolysis reaction were monitored by quantifying the formation of the different hydrolyzed products, e.g., γ-casein and proteose peptones, using sodium dodecyl sulfate polyacrylamide gel electrophoresis and reverse phase high performance liquid chromatography. Cross-linking of lysine residues with glutamyl residues by transglutamination and lysine-sugar-lysine cross-linking through the Maillard reaction clearly affected plasmin-induced hydrolysis negatively and reduced the susceptibility of b-casein to plasmin-induced hydrolysis. This could have been due to 1) the modification of lysine making it unrecognizable to the substrate-binding pocket of plasmin, and 2) the cross-linking preventing the release of hydrolyzed peptides. In terms of controlling plasmin-induced hydrolysis, it appeared that Effect 1 played a more major role in Maillard reaction cross-linking and that Effect 2 played a more major role in transglutamination. It can be concluded from this study that the cross-linking of proteins may be a useful tool for controlling the plasmin-induced hydrolysis of milk proteins and therefore for minimizing the texture- and flavor-related defects that are caused by the release of hydrolyzed peptides.

Key Words: plasmin, transglutamination, Maillard reaction

1025 (W079) Optimization of γ-aminobutyric acid production of *Lactobacillus plantarum* and determination of flavor substances in γ-aminobutyric acid-enriched fermented milk.

L. Li[1], C. Man[2,3], T. Li[1], Y. Shan[2,3], Y. Deng[1], M. Ding[1], M. Guo*[4], and Y. Jiang[1,2,3], *[1]Dep. of Food Science, Northeast Agricultural University, Harbin, China, [2]National Dairy Engineering and Technology Research Center, Northeast Agricultural University, Harbin, China, [3]Synergetic Innovation Center of Food Safety and Nutrition, Harbin, China, [4]University of Vermont, Burlington.*

Gamma-Aminobutyric acid (GABA) is a nonprotein amino acid with positive physiological properties to animals and human. Two objectives were achieved in this work: 1) optimization of the GABA production of *Lactobacillus plantarum* NDC 75017 isolated from traditional yoghourt in Inner Mongolia of China, and 2) exploration of the flavor variations of GABA-enriched fermented milk by this strain in shelf life. High performance liquid chromatography (HPLC) and o-phthaldialdehyde (OPA) precolumn derivatization were used to determine the GABA concentrations in MRS culture media under different fermented conditions. GABA maximum accumulation increased to 3.004 folds of the original production in the following optimized condition: 75 mM L-solium glutamate (L-MSG), 20 μM pyridoxal 5'-phosphate (*P*LP), 3 mM $CaCl_2$, 3% inoculation in MRS and 48 h fermentation with the initial pH value of 4.5. In the above condition, *L. plantarum* NDC 75017 was cultured to be the starter of GABA-enriched fermented milk and it was stored in 4°C for 21 d. Six typical flavor substances were measured by spectrophotometry and HPLC at 11 point-in-time during the whole storage. Diacetyl increased gradually from 3.226 to 4.975 mg/L. Acetaldehyde went up at first, peaked at the third day with 8.9 g/L and went down slowly to 7.259 g/L at last. Citric acid, pyruvic acid, lactic acid and formic acid contents of fermented milk were stable without significant variations and the concentrations of them at the end of storage were 132.772 mg/L, 10.782 mg/L, 109.268 mg/L and 82.757 mg/L, respectively. Compared to general fermented milk products, lower content of diacetyl and lactic acid but higher concentration of formic acid showed in the GABA-enriched fermented milk and other three flavor substances were similar between them. Results in the present study suggested that the optimized GABA-producing *L. plantarum*NDC 75017 could be the potential starter applied in the manufacture of fermented milk or other dairy products with healthcare functions and unique flavors. *This work was supported by National Science and Technology Project (2011AA100902) and National Natural Science Foundation of China (31171718).*

Key Words: γ-aminobutyric acid, *Lactobacillus plantarum*, fermented milk

1026 (W080) Comparison of odd and branched chain fatty acids profiles of cow, yak, buffalo, Jersey cattle, goat, camel and horse milk fat. L. Ma[1,2], D. P. Bu[2], J. T. Chen[2], and J. Q. Wang[*2], *[1]Inner Mongolia Agricultural University, Huhhot, China, [2]State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

To unravel the expression profile of odd and branched chain fatty acids (OBCFA) in cow (n = 20), yak (n = 20), buffalo (n = 20), Jersey cattle (n = 20), goat (n = 20), camel (n = 8) and horse (n = 8) milk samples which were collected around the fourth month of lactation for each species from February to April 2013, composition and variation were detected by gas chromatography-mass spectrometry selected scan mode (GC–MS/SCAN) (7890N-5975C, Agilent Technologies Co., Ltd., USA). Descriptive statistics and Duncan's multiple comparison of OBCFA profiles were obtained by SAS 9.1 via GLM model (SAS Institute Inc., Cary, NC). All OBCFA data sets were analyzed by principal component analysis (PCA) using the Unscrambler 9.8 (CAMO SOFTWARE AS, Oslo, Norway) and submitted to further hierarchical clustering using Cluster 3.0 software (USA). Significant differences in milk OBCFA composition of different species were observed. In cow, yak, buffalo and Jersey cattle milk, the highest composition of OBCFA were *iso*-C15:0 and C15:0, in goat milk were C15:0 and *anteiso*-C17:0, while in horse and camel milk were *iso*-C15:0 and *anteiso*-C17:0, respectively. Among various species milk, *anteiso*-C13:0 accounted for the smallest percentage of OBCFA. Total OBCFA composition was highest in yak milk. Most of the individual OBCFA were significantly highest in yak milk, except for *anteiso*-C17:0 which was a little lower than in camel milk. However, most individual OBCFA and the total amount of OBCFA in horse milk were significantly lower than in other species' milk. The cluster analysis result showed that cow, buffalo, Jersey cattle and yak milk samples comprised a major sample cluster, and goat milk added to this group yielded another cluster. Camel and horse milk were in another major cluster. In addition, principal component analysis (*P*CA) result could also be used to group different species according to OBCFA and demonstrate an effective way to distinguish between yak milk and others' milk. It was concluded that milk from different species had its special OBCFA profile.

Key Words: odd and branched chain fatty acids, species milk, gas chromatography-mass

1027 (W081) Detection and comparison of major and trace elements from different species milk by inductively coupled plasma–mass spectrometry. L. Ma, D. P. Bu, J. T. Chen, and J. Q. Wang**, State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

Milk contains lots of nutrients, such as proteins, lipids, carbohydrates, vitamins and elements. As a complex biological fluid and an excellent source of macro and micro nutrients, milk can play an important way in meeting the nutritional requirements for individuals. The content of nine major and trace elements in cow (n = 20), yak (n = 20), buffalo (n = 20), Jersey cattle (n = 20), goat (n = 20), camel (n = 8) and horse (n = 8) milk samples which were collected around the 4thmonth of lactation for each species from February to April 2013 in China have been determined by inductively coupled plasma–mass spectrometry (ICP–MS) (Agilent 7700X, Agilent Corporation, United States) after microwave digestion. Descriptive statistics and Duncan's multiple comparison of protein contents were obtained by SAS 9.1 via GLM model (SAS Institute Inc., Cary, NC). To check the applicability of the proposed method to the analysis, two certified reference materials available for powder skim milk (GBW10017) and for cabbage power (GBW1001) were analysed to obtain satisfactory results in all cases. The result showed that the contents of major elements (Na, Mg, K, Ca, Fe) and trace elements (Mn, Co, Zn, Se) in different species milk were significantly different. All of the major elements were lowest in horse milk. Much higher concentrations of Mg and Ca were found in buffao milk. The content of Fe was highest in cow milk. Na and K were found highest in camel milk and goat milk, respectively. The concentrations of trace elements (Mn, Co, Zn, Se) were almost higher in cow milk than in other species milk, except for Se, which was a little lower than in buffalo milk. The content of Co was found nearly the same in cow, yak, buffalo, Jersey cattle, camel and horse milk, except for in goat milk, which was a little lower. In addition, Se was not detected in horse milk. It was concluded that the contents of major and trace elements in milk from different species were various and the trace element of Se was not detected in horse milk in this study.

Key Words: major and trace elements, species milk, inductively coupled plasma–mass spectrometry

1028 (W082) Identification of microRNA in fresh milk of cow and goat. D. P. Bu[1], L. Ma[1], X. M. Nan[1], J. J. Loor[2], and J. Q. Wang[*1], *[1]State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China, [2]University of Illinois, Urbana.*

MicroRNAs (miRNAs) are a class of small RNA molecules (~22 nt) that inhibit translation or induce degradation of pro-

tein-coding mRNAs containing complementary sequences to mRNAs. Recent studies have demonstrated the presence of miRNAs in body fluids such as serum, plasma, saliva, urine and milk. The objective of this study was to identify the differences of microRNA profiles between cow whey and goat whey. Cow whey samples and goat whey samples without milk fat, somatic cells and major proteins were obtained by a series of centrifugations and filtrations. miRNA was isolated and the quantity of RNA measured. Isolated miRNAs were amplified and sequenced by Solexa sequencing technology. After bioinformatics analysis, 381 loci possessed the typical stem-loop structures matched to the known miRNA hairpins and a total of 34 loci with novel hairpins were identified as novel miRNAs in cow whey. In goat whey, a total of 111 microRNAs were obtained, of which 13 were novel microRNAs. Among all the microRNAs detected in cow and goat whey, 29 miRNAs were common between these species. Overall, the miRNA profile of cow whey and goat whey differed significantly.

Key Words: fresh milk, whey, microRNA

1029 (W083) Sodium azide and potassium dichromate not suitable preservative of raw milk for detection β-lactamase by cylinder plate method. Y. Zhang[1,2,3], N. Zheng[1,2,3], F. Wen[1,2,3], S. Li[1,2,3], S. Zheng[1], and J. Wang[*1,2,3], *[1]Ministry of Agriculture– Laboratory of Quality and Safety Risk Assessment for Dairy Products, Beijing, China, [2]Ministry of Agriculture– Milk and Dairy Product Inspection Center, Beijing, China, [3]State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

Upon selecting the appropriate sample of raw milk, keeping the stability of physicochemical property of β-lactamase relevant compounds is essential for its successful detection and identification in systematic analysis. However, there is no particular standard pre-treatment procedure for detection of β-lactamase in raw milk. This study examined the storage time of refrigeration (4 h, 8 h, 24 h, 48 h) and freeze (1 d, 7 d, 30 d), the temperature (25°C, 40°C, 60°C) and times (1, 3, and 5) of thawing for freeze sample and the kinds of preservative (sodium azide, potassium dichromate, sodium thiocyanate, bronopol, methanol) using cylinder plate method. Milk sample, collected from individual cow and negative for β-lactamase testing by cylinder plate method, was divided into 10 aliquot of the milk sample, two aliquot of the milk sample adding nothing were the control group, eight aliquot of the milk sample adding 4 U/mL β-lactamase were the experiment group. Refrigeration time within 48 h and freeze time within 30 d had no influence on the detection result of β-lactamase, thawing temperature below 60°C and thawing times below five times for freeze sample were also no influence. β-lactamase could not be detected when adding sodium azide and potassium dichromate in raw milk, whereas sodium thiocyanate, bronopol and methanol had no effect, suggesting sodium azide and potassium dichromate were not suitable preservative of raw milk for detection β-lactamase by cylinder plate method.

Key Words: pre-treatment, β-lactamase, raw milk

1030 (W084) Discrimination of reconstituted milk and over-processed milk in pasteurized and UHT milk. H. Wang[1,2,3], N. Zheng[1,3], F. Wen[1,3], H. Wang[2], X. Guo[1,3], S. Li[1,3], and J. Wang[*1,3], *[1]Ministry of Agriculture– Laboratory of Quality and Safety Risk Assessment for Dairy Products, Beijing, China, [2]College of Animal Science and Technology, Yangzhou University, China, [3]State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

The objective of the present study was to distinguish over-processed milk and reconstituted milk by comparing the heat treatment indicators in raw milk, over-processed milk and raw milk plus reconstituted milk under both pasteurized and ultra high temperature (UHT) conditions. The contents of furosine and lactulose, as well as the ratio of lactulose to furosine were investigated. Lactulose was detected using UV spectrophotometer by enzymatic method (ISO 11285/2004) with modifications and furosine was detected by using high-performance liquid chromatography (HPLC) according to ES ISO 18329/2012. The content of furosine was less than 12 mg/100 g protein, when the milk was pasteurized from pure raw milk; if the content of furosine was more than 12 mg/100 g protein, it can be considered as reconstituted milk when L/F was less than 1, otherwise it could be regarded as over-processed milk when L/F was higher than 1. If it was produced from pure raw milk under UHT conditions, the content of furosine would be less than 140 mg/100 g protein; if the content of furosine was more than 140 mg/100 g protein, it can be considered as reconstituted milk when L/F was less than 2, otherwise it could be regarded as over-processed milk when L/F was higher than 2. Our results suggest that over-processed milk and reconstituted milk in pasteurized and UHT milk might be differentiated by the content of furosine and the ratio of lactulose and furosine (L/F).

Key Words: reconstituted milk; over-processed milk; lactulose/furosine

1031 (W085) Caseinomacropeptide index (cmp), microbiology and protein content of UHT chocolate milk-whey-based drinks in Brazil. F. P. Paula[1], L. M. Melgaço[1], A. B. Jardim[1], C. F. A. M. Penna[2], L. M. Fonseca[1], M. R. Souza[2], M. P. Cerqueira[2], and M. O. Leite[*2], *[1]Universidade Federal de Minas Gerais, Belo Horizonte, Brazil, [2]Universidade Federal de Minas Gerais* (*School of Veterinary Medicine), Belo Horizonte, Brazil.*

Ultra high temperature (UHT) milk-whey-based-drinks are obtained by processing a mix of milk and cheese whey. In Brazil, this may additionally be added of food ingredients, vegetable fat, and other milk derivatives. The intake of this product is popular among children in Brazil, and it is commonly used to replace milk consumption. Consequently, nutritional concerns emerge because of the low protein content due to whey addition. The objective of this work was to evaluate the protein content and microbial contamination, and to estimate the caseinomacropeptide index (CMP) of this beverage. Fifty-six samples of UHT chocolate milk-whey-based drinks from seven dairy plants, and eight production lots each were collected in the city of Belo Horizonte, MG (Brazil) and analyzed for protein content (Kjeldahl), CMP index by high performance liquid chromatography (HPLC) and count of aerobic mesophilic bacteria (total plate count). Descriptive statistics was used. All samples were in compliance with Brazilian standards for aerobic mesophilic countings (< 1.0 CFU/mL). Average CMP index (mg/L), and protein content (g/100 g) for the seven brands are showed in Table 1031. Samples with higher CMP index were correlated with lower protein content (Pearson correlation of -0.7 at $P = 0.07$), as expected. Although protein content results were in compliance with Brazilian legislation, the low levels found in several samples are indicative of potential low protein intake by children with high consumption of this food.

Key Words: milk-whey-based-drinks, caseinomacropeptide index, protein content, microbiology

Table 1031.

Brand	CMP (mg/L)	Protein (g/100g)
A	912.5+	1.15+
B	646.31+	2.06+
C	611.24+	2.93+
D	566.64+	2.04+
E	498.93+	1.73+
F	332.67+	2.93+
G	328.23+	2.49+

1032 (W086) Stability of vitamin a palmitate in raw skim milk and apple juice on exposure to ultraviolet light. M. S. Mohan[*], and F. Harte, *University of Tennessee, Knoxville.*

Vitamin A palmitate is commercially fortified in milk. Earlier studies have indicated that the vitamin A fortified in milk is associated with the casein micelles in milk. Our objective was to study whether casein micelles protect vitamin A palmitate from degradation on exposure to ultraviolet (UV) radiation. For this purpose raw skim milk and apple juice was fortified with vitamin A palmitate (1.4 mM) after dispersing in ethanol (2.44% v/v ethanol in sample) with rotary homogenization at 10, 000 rpm for 3 min. The vitamin A milk and juice samples were then subjected to strong UV radiation (365 nm, intensity at the surface of transilluminator 5300μW/cm^2) for 0, 5, 10, 15, and 20 min. The vitamin A was extracted with hexane and quantified by using a normal phase HPLC at 325 nm. Vitamin A milk samples were subjected to size exclusion chromatography (SEC) and the fractions pertaining to the same peak at 280nm were pooled, then freeze dried and analyzed for vitamin A content. There was rapid degradation of vitamin A palmitate in juice samples, with a reduction of 59% of vitamin A of the initial amount added, on exposure to 20 min of UV light. The vitamin A content was 100%, 97%, 88%, 67% and 41% (± 4%) of the initial amount added, on subjecting to UV exposure for 0, 5, 10, 15, and 20 min, respectively. While the vitamin A in milk samples degraded only 6% over 20 min of UV exposure, with a degradation pattern 100%, 100%, 99%, 97% and 94% (± 4%) of the initial amount added, on subjecting to UV exposure for 0, 5, 10, 15, and 20 min, respectively. The difference in the percentage of vitamin A between milk and juice was especially significant after 15 and 20 min of UV light exposure ($P < 0.01$). The quantification of vitamin A in the SEC fractions indicated that vitamin A palmitate associated only to casein micelles in milk with a recovery of 42% of the initial amount added within the casein section. The results indicate that the association of vitamin A palmitate and casein micelles in raw skim milk samples provide a protective effect to vitamin A palmitate against degradation on exposure to UV light.

Key Words: vitamin A palmitate, ultraviolet, casein, milk

1033 (W087) Effect of abomasal ferrous lactate infusion of dairy cows on milk proteins. A. Wang[*1], A. M. Dietrich[1], S. Duncan[1], K. F. Knowlton[1], and W. Slade[2], *[1]Virginia Tech, Blacksburg, [2]University of North Carolina at Chapel Hill, Chapel Hill.*

Water makes up more than 80% of the total weight of milk. However, the influence of water chemistry on milk quality has not been extensively studied. Heavy metals in bovine drinking water may affect the synthesis of milk and subsequent milk quality. The objective of this study was to determine the in-

teraction of ferrous lactate infusion in dairy cows, representing the intake of iron through drinking water, on qualitative changes in protein composition of their milk. Four ruminally-cannulated cows each received aqueous infusions of ferrous lactate at 0, 200, 500 or 1250 mg of Fe/d in a Latin Square design. A wash-out period (7 d) existed between each infusion period (7 d). Raw milk was collected at d 6 of each infusion period and was homogenized and pasteurized before analysis. two-dimensional electrophoresis (2-DE) coupled with matrix-assisted laser desorption/ionization time-of-flight/time-of-flight (MALDI-TOF/TOF) high-resolution tandem mass spectrometry analysis was applied to characterize the milk proteins. About 56 protein spots were identified and represented the major and minor casein and whey proteins. Although the protein compositions were similar across cows, the intensity of specific protein spots such as α-S1-casein and k-casein showed differences among different cows. Within-cow comparison demonstrated diminished spot intensity and less focusing along the pI gradient for some spots with increasing ferrous infusion. Such variation may indicate that high iron in bovine drinking water affects some cows more than others. Cow D presented the most stable and consistent protein spots both in position and intensity throughout the infusion period. The content of copper and iron in milk from this cow was consistent and was very near the four cow average. In contrast, milk from cow C presented more α-S1-casein spots when consuming high iron-contaminated water then when consuming regular drinking water; the iron and copper concentration in her milk decreased with increasing infusion concentration. However, cow A lost several α-S1-casein spots when drinking high ferrous sulfate concentration water. The iron-binding protein, lactoferrin was observed at both control and high ferrous infusion periods for cows. There is qualitative evidence that iron in drinking water may affect milk proteins differently in different cows.

Key Words: proteins, lactoferrin, iron

1034 (W088) Effect of high hydrostatic pressure processing on in vitro digestion of milk proteins and fats. D. X. Ren[1,2], D. L. Van Hekken[1], M. H. Tunick[1], and P. M. Tomasula[*1], *[1]USDA, ARS, ERRC, Dairy and Functional Foods Research Unit, Wyndmoor, PA, [2]Institute of Dairy Science, College of Animal Science, Zhejiang University, Hangzhou, P.R., China.*

The use of high hydrostatic pressure processing (HPP) is increasing in popularity in the food industry. Its ability to modify milk proteins and fats suggests that it may be useful in creating foods that suppress appetite; however, its effect on the digestibility of proteins and fats is unclear. The objective of this study was to compare the change in clot size with time during in vitro simulated fasting gastro-intestinal digestion of protein and fat for HPP-treated raw whole milk (WP), homogenized raw whole milk (WHP), and skim milk (SP) to that of untreated raw whole (WR) and raw skim milk (SR), and WR and SR milk treated by HTST pasteurization (72°C, 15 s) with or without homogenization. HPP was conducted at 600 MPa (3 min, 21°C). Milk digestion procedures followed the 2012 U.S. Pharmacopeia using simulated gastric fluid (SGF) for 1 h followed by simulated intestinal fluid for 2 h. The average particle size of WR 8.5 ± 0.3 μm remained unchanged with all processing treatments while the average particle size of SR increased from 1.3 ± 0.3 μm to 4.6 ± 0.6 μm with HPP treatment only. The clots that formed on addition of SGF for WR and SR and with the various processing treatments were then followed for 3 h using a light-scattering particle-size analyzer. The clot sizes of processed WR samples were > those for the raw samples but were not different after 3 h. The clot size for SR was < that for SP. after 3 h but the amounts of SR and SP. protein digested were not different ($P < 0.05$). In vitro % protein digestibilities of WR and SR were similar regardless of treatment, ranging from 85 to 90%, except for HPP-treated WR and SR which ranged from 62 to 70%. Free fatty acid release (FFAR) decreased in the order WHP > WR > WP, indicating that WHP was the most digestible due to the increased surface area for enzyme contact and fat breakdown. Stearic and oleic acids, located on the outside of the triglyceride molecule, degraded approximately twice as fast as the other fatty acids. FFAR for WP was 40% < that of WR. Results indicate that HPP processing may possibly be used to moderate in vitro protein and fat digestion of milk.

Key Words: high pressure processing; digestibility; free fatty acids

---

1035 (W089) Effect of storage temperature on the physio-chemical properties of skim milk powders treated with chelators. V. Sikand[*1], P. S. Tong[1], S. Vink[1], and S. Roy[2], *[1]Dep. of Dairy Science, California Polytechnic State University, San Luis Obispo, [2]Dep. of Statistics, California Polytechnic State University, San Luis Obispo.*

The objectives of this study were to determine the impact of storage temperature on functional properties– solubility, opacity and heat stability compared to freshly manufactured skim milk powder (SMP) samples treated with mineral chelators. This study was conducted by adding 5, 15, and 25 mM sodium citrate dihydrate (SCD), sodium polyphosphate (SPP) and disodium EDTA (DSE) to skim milk concentrate (30% total solids) and adjusting the concentrate to 6.65 pH before spray drying. One set of sample bags were stored at room temperature (22°C). The second sets of bags were kept at 37°C for 3 mo. The experiment was repeated twice. Samples were tested for solubility index (SI) and reconstituted to contain 9% TS and tested for opacity by using a Hunter Lab Colorimeter. Heat stability was determined by measuring the heat coagulation time (HCT) at 140°C as the time required for visible flocculation for samples. SI indicated high solubility of all SMP

samples. However, lower values for SI were observed for samples treated with 5mM SPP. and DSE (0.13 mL) as compared to samples treated with SCD (0.3mL). Furthermore, low SI values were observed with an increasing level of chelating agents regardless of chelator type. No significant difference was observed in SI of samples stored at 37°C as compared to SI tested for freshly manufactured samples. A decreased opacity (L* value) or an increase in the lightness of samples was found with increasing levels of mineral chelating salt treatment ($P < 0.001$). Furthermore, lower L* values were observed in samples stored at 37°C ($P < 0.001$) as compared to freshly manufactured samples. Heat stability studies showed that SMP (PH 7.0) treated with 5mM DSE or SCD chelators had higher HS (> 30 min) as compared to the SPP. (16 min). Samples treated with 15mM SPP. showed significantly higher HS (20 min) as compared to SCD or DSE treated samples. Samples showed poor HS (< 5 min) chelator type at 25mM concentration level. Slightly lower HCT values were observed for samples stored at 37°C ($P < 0.001$) as compared to freshly manufactured samples, regardless of any concentration level. The results from this study showed that storage temperature may impact the functional properties.

Key Words: SMP, chelators, solubility, heat stability

1036 (W090) Effect of sunflower oil, vitamin E and selenium inclusion in the diet of dairy cows on the sensory acceptability of milk. L. F. D'Abreu*, C. Rodrigues, A. Saran Netto, J. L. Guimarães, M. A. Silva, and N. D. P. Lopes, *School of Animal Science and Food Engineering, University of São Paulo, Pirassununga, Brazil.*

The objective of the present study was to evaluate the effect of sunflower oil, vitamin E and selenium inclusion in the diet of dairy cows on the acceptance of sensory attributes of milk. Thirty-two Jersey cows in early lactation were divided into four experimental groups in a complete randomized design. The animals were randomly assigned to receive one of the following diets: 1) control (C, $n = 8$); 2) 3.5 mg selenium/kg dry matter (DM) + 3000 IU vitamin E/kg DM (SE, $n = 8$); 3) 4% inclusion of sunflower oil (total diet DM basis) (O, $n = 8$), 4) 4% inclusion of sunflower oil (total diet DM basis) + 3.5 mg selenium/kg DM + 3000 IU vitamin E/kg DM (OSE, $n = 8$). Before sensory evaluation, the milk was pasteurized. Sixty untrained tasters received the samples in complete blocks and used a nine-point hedonic scale for acceptance testing regarding the attributes color, odor, flavor and mouthfeel of milk and a scale of intensity difference of odor and flavor for the test of difference from the control. Data were submitted to ANOVA analysis of variance and Tukey test was conducted to compare means, to the level of 5% of significance using the PROC MIXED of SAS version 9.1. In the test of difference from the control, no difference ($P > 0.05$) between milk from cows fed the C diet and those from cows fed the SE, O and OSE diets was observed for the evaluated attributes- odor and flavor. The acceptability of the commercial milk color was higher ($P < 0.05$) when compared to the other dietary treatments (8.10 *vs*. C = 6.56; SE = 5.73; O = 6.51; OSE = 7.03). The attributes odor, flavor and mouthfeel showed no effect of dietary treatment ($P > 0.05$) in acceptance by the consumer. These results demonstrate the feasibility to produce milk from cows supplemented with sunflower oil, selenium and vitamin E.

Key Words: antioxidants, consumers acceptance, dairy