114   Assessing essential amino acid availability in lactating dairy cows infused with methionine, lysine, and histidine or leucine and isoleucine. X. Huang1, P. Yoder1,2, and M. Hanigan1, Virginia Polytechnic Institute and State University, Blacksburg, VA, USDA-Agricultural Research Service, Madison, WI.

The objective of this study was to evaluate the effects of jugular infusion of 2 groups of AA on essential AA availability and utilization by the mammary glands. Four cows (78 ± 10 DIM) were assigned to 4 jugular infusion treatments: saline (CON), methionine plus lysine plus histidine (MKH), isoleucine plus leucine (IL), or MKH plus IL (MKH-IL) in a 4 × 4 Latin square design. Each period was 16 d in length with 8 d of adaption followed by 8 d of jugular AA infusion. Infusion rates were 10 g of methionine, 38 g of lysine, 20 g of histidine, 50 g of leucine and 22 g of isoleucine per day. On last day of each period, a 13C labeled AA mix was infused into the jugular vein over a 6 h period, and blood samples were collected hourly and assessed for AA enrichment. Cows were fed a basal diet consisting of 15.2% crude protein with adequate rumen degradable protein but 15% deficient in metabolizable protein. Milk production increased significantly with infused IL (P < 0.04), but did not change in response to MKH (P = 0.44). Milk protein concentration and yield increased for the MKH infusion (P < 0.01) whereas milk protein yield tended to increase for IL (P = 0.08). Total plasma AA entry rates were estimated for each EAA by fitting a 6-pool, dynamic model to observed plasma, 13C AA enrichment. The blood Met entry rates for CON, MKH, IL and MKH-IL were 57, 82, 62, 90 g/d respectively after subtracting infused Met. MKH infusion significantly increased Met entry (P < 0.01) and IL infusion tended to increase Met entry (P = 0.06), which was related to greater Met intake (P = 0.09). The increase in Met entry with MKH infusion reflected increased Met availability from the diet or increased recycling of Met in the body. Essential AA transport and metabolism by the mammary glands will be reported.

Key Words: dairy cow, essential AA, whole-body entry rates

115   Effects of jugular infused methionine, lysine, and histidine or leucine and isoleucine on protein expression and post-translational modification. P. S. Yoder1,2, W. K. Ray3, R. F. Helm3, X. Huang1, C. Schumacher1, E. Huang1, I. A. M. Teixeira4, and M. D. Hanigan1, 1Department of Dairy Science, Virginia Tech, Blacksburg, VA, 2Perdue AgriBusiness LLC, Salisbury, MD, 3Department of Biochemistry, Virginia Tech, Blacksburg, VA, 4UNESP-Universidade Estadual Paulista, Jaboticabal, SP, Brazil.

The objective was to evaluate protein expression and post-translational modifications in mammary and muscle tissues of cows supplemented with 2 AA groups. Four lactating cows were assigned to treatments of saline (CON), methionine plus lysine plus histidine (MKH), isoleucine plus leucine (IL), or MKH plus IL in a 4 × 4 Latin square. Milk protein yield increased with MKH and IL independently with the MKH-IL treatment yielding a 9.6% increase versus CON. Mammary and muscle proteomes were assessed for total and phosphorylated abundance and the respective ratio using proteomics. Total and site-specific phosphorylated abundances of mammalian target of rapamycin (mTOR), ribosomal protein S6 kinase (S6K1), ribosomal protein S6 (rpS6), and eukaryotic initiation factor 2a (eIF2a) were assessed by western immunoblotting. The treatments both independently affected the phosphorylation ratio of mTOR pathway proteins in the udder as indicated by multivariate analyses. For the udder proteome, there was a tendency for a treatment interaction on total and phosphorylated abundance as well as the phosphorylation ratio. Univariate proteomic analysis revealed an enhanced phosphorylation ratio of mitogen-activated protein kinase 1 (MAP2K1) by MKH and IL and insulin receptor substrate 1 (IRS1) by MKH treatment only which may indicate negative mTOR feedback. Western immunoblotting indicated decreased total and phosphorylated abundance of S6K1 as well as phosphorylation ratio for the MKH infusion. There was a positive treatment interaction for total and phosphorylated abundance of rpS6, S6K1, and eIF2a as well as the phosphorylation ratio of rpS6. No significant changes were observed in muscle. Results indicate that supplementing MKH or IL affects protein expression and phosphorylation ratio of many udder proteins. However, the changes in mTOR signaling proteins were generally opposite of expectations. The latter appears to be the result of negative feedback arising from infusion of MKH and IL alone and when infused in combination, less negative feedback and positive treatment interaction on mTORC1 targets.

Key Words: milk protein, mammalian target of rapamycin (mTOR)


The objective of this study was to characterize the effects of genomic predicted transmitting ability values for protein yield (gPTA) and concentration of metabolizable protein (MP) on milk production in first lactation cows. It was hypothesized that cows of different gPTA would respond differently to diets differing in MP concentration. To test this hypothesis, 56 genomically tested, first lactation Holstein cows were blocked into quartiles by gPTA and randomly assigned to a diet containing an adequate (ADMP; 16.5%CP, 30.3%NDF) or low (LOMP; 14.5%CP, 32.8%NDF) concentration of MP. Diets were formulated to contain identical base ingredients of corn silage (40%), alfalfa silage (20%), ground high moisture shell corn (15.5%), canola meal (8%), roasted soybeans (4%), dried distillers grains with solubles (2%), soybean hulls (1.5%), and a vitamin-mineral mix (2.5%). To these base ingredients, ADMP had an additional 6.5% canola meal and LOMP had an additional 6.5% soy hulls added. Cows were fed individually once daily and milked thrice daily, with intake and milk yield measured daily. Milk was sampled at 6 consecutive milkings weekly and body weight (BW) was measured twice weekly for 2 wk before and for 12 wk while consuming treatment diets. Pretreatment measurements were used for covariate adjustment in the statistical model, contrasts for diet and diet by gPTA block interactions were calculated, and P ≤ 0.05 was considered significant with 0.05 < P ≤ 0.10 trending toward significance. Cows consuming ADMP had higher DMI, BW, and production of milk and milk components than LOMP. Milk and milk protein yield increased linearly with gPTA block for cows fed ADMP, but there were very small differences in these measurements when fed LOMP (linear gPTA block × diet interaction P < 0.08). Yield of fat and energy increased and BW decreased linearly with gPTA block irrespective of diet. Feed and nitrogen efficiencies were higher with ADMP and with increasing gPTA, but these factors did not interact with each other. In conclusion, the expression of genetic differences in milk and protein yield was blunted by feeding LOMP, but not ADMP, in first-lactation Holstein cows.

Key Words: milk protein, genetics
A feeding trial was performed to determine the effects of rumen-protected lysine supplementation in lactating cattle diets differing in CP content. Twelve multiparous mid-lactation Holstein cows were blocked by DIM into a triplicate 4 × 4 Latin Square. Diets were arranged in 2 × 2 factorial design with 2 levels of CP (LO = 15%, HI = 17%) with or without lysine supplementation (+L, -L). Periods consisted of 14 d of adaptation followed by a sampling period of 3 d. During sampling periods, daily milk yield and DMI were recorded, and total collections of urine and feces were taken. Milk, urine, fecal, and plasma samples were collected for additional analysis. No significant interactions were found between CP content and Lys supplementation (P ≥ 0.14). DMI was affected by dietary CP (P ≤ 0.01) but not Lys supplementation (P = 0.21; LO-L = 25.3 kg/d; LO+L = 26.0; Hi-L = 27.5; Hi+L = 28.2; SEM = 1.42). Milk yield increased with CP content (P = 0.03) and Lys supplementation (P ≤ 0.01; LO-L = 34.6 kg/d; LO+L = 36.6; Hi-L = 36.1; Hi+L = 38.0; SEM = 1.87). Energy-corrected milk yields increased with dietary CP (P = 0.02) and supplemental Lys (P ≤ 0.01; LO-L = 34.98; LO+L = 37.06; Hi-L = 35.71; Hi+L = 39.02; SEM = 1.79). Milk fat (LO-L = 1.44 kg/d; LO+L = 1.52; Hi-L = 1.49; Hi+L = 1.60; SEM = 0.08) and milk protein (LO-L = 1.09 kg/d; LO+L = 1.18; Hi-L = 1.19; Hi+L = 1.25; SEM = 0.056) yields were raised by dietary CP (P = 0.05 and P ≤ 0.01 for fat and protein, respectively) and supplemental Lys (P = 0.01 for both fat and protein). Increased CP content increased milk protein %, milk urea nitrogen, and fecal N output (P ≤ 0.01), but there was no effect of Lys (P ≥ 0.56). No changes were seen in plasma glucose, NEFA, or BHBA as a result of either dietary CP or Lys supplementation (P > 0.10). The analysis shows that supplementing Lys in low CP diets can result in similar milk production to high CP diets without Lys supplementation.

Key Words: lysine, low CP diet, N output

### Table 1 (Abstr. 118). Amino acid net uptake in the mammary gland

<table>
<thead>
<tr>
<th>Essential AA, g/g</th>
<th>NI SCP</th>
<th>NI DCP</th>
<th>HI SCP</th>
<th>HI DCP</th>
<th>SE</th>
<th>CP</th>
<th>Insulin</th>
<th>CP × I</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arg</td>
<td>0.30</td>
<td>0.36</td>
<td>0.20</td>
<td>0.27</td>
<td>0.04</td>
<td>0.44</td>
<td>0.60</td>
<td>0.41</td>
<td></td>
</tr>
<tr>
<td>Leu</td>
<td>0.41a</td>
<td>0.40a</td>
<td>0.22b</td>
<td>0.49a</td>
<td>0.06</td>
<td>&lt;0.01</td>
<td>0.22</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Lys</td>
<td>0.65b</td>
<td>0.51bc</td>
<td>0.41c</td>
<td>0.89b</td>
<td>0.11</td>
<td>0.06</td>
<td>0.37</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Met</td>
<td>1.10</td>
<td>1.14</td>
<td>1.02</td>
<td>1.02</td>
<td>0.08</td>
<td>0.17</td>
<td>0.17</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>Phe</td>
<td>0.56a</td>
<td>0.50b</td>
<td>0.39b</td>
<td>0.58a</td>
<td>0.06</td>
<td>0.26</td>
<td>0.42</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Thr</td>
<td>0.63a</td>
<td>0.44a</td>
<td>0.32b</td>
<td>0.18b</td>
<td>0.07</td>
<td>0.09</td>
<td>&lt;0.01</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td>Val</td>
<td>0.27</td>
<td>0.32</td>
<td>0.25</td>
<td>0.40</td>
<td>0.08</td>
<td>0.12</td>
<td>0.62</td>
<td>0.48</td>
<td></td>
</tr>
</tbody>
</table>

Amino acid supply is an important determinant of milk production. In addition, insulin is a hormone that indirectly regulates protein synthesis. It has been previously observed that hyperinsulinemia stimulates amino acid utilization. The aim of this study was to investigate mammary gland efficiency (MGE) of use of essential amino acids (EAA) in response to dietary protein and hyperinsulinemia. Six lactating Holstein (590 kg BW; 33.0 kg milk/day) cows were randomly assigned in a 2 × 2 factorial arrangement crossover design. The diet was formulated based on NRC requirements for milking cows to be protein sufficient (17.5%; SCP) or deficient (14.0%; DCP). The diets were composed of corn silage, mixed grass and legume silage, and a concentrate mix. Milk samples were collected daily. Arterial and venous blood were sampled via catheters once an hour for 8 h without infused insulin (NI), and again after 4 d of an intravenous infusion of 1 μg of insulin/kg of BW per h plus varying glucose to achieve hyperinsulinemic-euglycemic status (HI). Plasma was prepared by centrifugation, and the supernatant analyzed for EAA concentrations by isotope dilution. MGE was calculated as:

$$\text{MGE} = \frac{\text{EAA in milk} - \text{EAA in feed}}{\text{Glucose infusion}}$$

Statistical analyses were performed using R Studio. Milk yield output was not affected by dietary protein and insulin. There was an interaction between dietary CP and insulin for MGE of Leu, Lys, and Phe. Hyperinsulinemia decreased the efficiency of use of Thr, but did not affect others. MGE for Ile and Val tended to increase and for Met and Thr tended to decrease with decreasing dietary CP.

Key Words: efficiency, essential, hormone
21 d in length with each divided by adaptation phase (d 1 to 14) and sample phase for statistical inferences (d 15 to 20). Treatments were as follows: cows fed a basal TMR + 150g of dried ground molasses (CON); basal TMR+ 150g of dried ground molasses + a commercially available rumen-protected lysine source (AjiPro-L, Ajinomoto Heartland Inc., Tokyo, Japan) (AJP, positive control); and basal TMR + 150g of dried ground molasses + a rumen-protected lysine prototype source (NPL, prototype B, NutraPass 50, ADM Animal Nutrition, Quincy, IL). Protected lysine sources were each included at a rate of 0.5% [w:w] of the DM. Data were analyzed using the MIXED procedure of SAS using 2 treatment orthogonal contrasts. Contrast 1 (CONT1): CON compared with NPL and contrast 2 (CONT2): AJP compared with NPL. Blood was sampled from the coccygeal vein or artery 4 and 8 h after feeding on 3 consecutive days before the first period and at the end of each period from each cow. There were no differences among treatments for either contrasts for total AA concentrations (P > 0.10). Plasma Lys concentration as a percentage of total AA (4.02 vs 4.30 ± 0.09) and plasma Lys concentration as a percentage indispensable AA (8.67 vs 9.30 ± 0.14) was greater for cows fed NPL than cows fed CON (P < 0.01, CONT1). Plasma Lys concentration as a percentage of total AA tended to be greater for cows fed AJP than cows fed NPL (4.43 vs 4.30 ± 0.01; P = 0.08, CONT2). Plasma 3-methyl-histidine concentration tended to be greater for cows fed CON than cows fed NPL (3.362 vs 3.39 ± 0.14 μM/L; P = 0.08, CONT1). In conclusion, Lys lipid protection seems to be an effective method of protection.

Key Words: rumen-protected lysine, MUN, milk protein

120 Succinate dehydrogenase activity and protein levels in liver of dairy cows fed TMR or in a pasture-based system. M. Garcia-Roche1,2, M. Carriquiry1, D. A. Mattiauda1, M. Ceriani1, A. Jasinsky1, A. Cassina2, and C. Quijano2, 1Departamento de Producción Animal y Pasturas, Facultad de Agronomía, Universidad de la República, Montevideo, Montevideo, Uruguay, 2Centro de Investigaciones Biomédicas, Departamento de Bioquímica, Facultad de Medicina, Universidad de la República, Montevideo, Montevideo, Uruguay.

Succinate dehydrogenase (SDH) is a mitochondrial enzyme involved in the respiratory chain, Krebs cycle and gluconeogenesis. Hence, a drop in its activity may lead to energy deficit or decreased gluconeogenesis, which could in turn affect milk yield and metabolic status. Our aim was to study the effect of 2 feeding strategies on the activity and protein expression of SDH in liver biopsies during early (35 DPP) and late lactation (180 DPP). Multiparous Holstein cows (n = 24, 664 ± 65 kgBW, 3.0 ± 0.4 BCS, spring calving) were assigned in a randomized block design to (G0) a total mixed ration (TMR) fed ad libitum (70% of the DM). Data were offered TMR (50% of G0 offer). Protected lysine sources were each included at a rate of 0.51% [w:w] of the DM. Data were analyzed using the MIXED procedure of SAS using 2 treatment orthogonal contrasts. Contrast 1 (CONT1): CON compared with NPL and contrast 2 (CONT2): AJP compared with NPL. Blood was sampled from the coccygeal vein or artery 4 and 8 h after feeding on 3 consecutive days before the first period and at the end of each period from each cow. There were no differences among treatments for either contrasts for total AA concentrations (P > 0.10). Plasma Lys concentration as a percentage of total AA (4.02 vs 4.30 ± 0.09) and plasma Lys concentration as a percentage indispensable AA (8.67 vs 9.30 ± 0.14) was greater for cows fed NPL than cows fed CON (P < 0.01, CONT1). Plasma Lys concentration as a percentage of total AA tended to be greater for cows fed AJP than cows fed NPL (4.43 vs 4.30 ± 0.01; P = 0.08, CONT2). Plasma 3-methyl-histidine concentration tended to be greater for cows fed CON than cows fed NPL (3.362 vs 3.39 ± 0.14 μM/L; P = 0.08, CONT1). In conclusion, Lys lipid protection seems to be an effective method of protection.

Key Words: succinate dehydrogenase, protein, liver, dairy cows

121 Essential amino acids influence milk fat synthesis in mammary epithelial cells. I. A. M. A. Teixeira1,2, P. S. Yoder1,2, E. Huang2, X. Huang2, and M. D. Hanigan2, 1Department of Animal Science, Unesp, Jaboticabal campus, Jaboticabal, SP, Brazil, 2Department of Dairy Science, Virginia Tech, Blacksburg, VA, 3Perdue AgriBusiness LLC, Salisbury, MD.

Increased milk fat yield has been observed when dairy cows are supplemented with amino acids (AA). The mechanism of this phenomenon is still unclear. Previously, amino acids have been reported to regulate mechanistic target of rapamycin (mTOR). This regulation may extend to de novo fat synthesis as mTOR is linked to activation of transcription factor sterol-regulatory-element-binding protein 1 (SREBP1). Activation of the latter will increase de novo fat synthesis. The objective of this study was to evaluate the effects of individual essential amino acids (EAA) on milk fat synthesis and regulation of the related transcription factors. The research was performed in 2 studies. In the first study, we measured de novo fatty acid synthesis in primary bovine mammary epithelial cells using isotopically labeled acetate as a tracer. The cells were subjected to 13 treatments varying in AA profile. Omission of l-arginine (Leu), l-methionine (Met), l-phenylalanine (Phe), all of the EAA, or all of the AA reduced (P < 0.05) the isotopic enrichment of C14:0, C16:0, and C18:0. Removal of these AA were associated with reductions in de novo synthesis of C14:0. Synthesis of C16:0 appeared to be more responsive with removal of any of the EAA causing a significant reduction in the isotope ratio. In the second study, we evaluated the effects of individual EAA on cellular signaling involved in milk fat synthesis using primary bovine mammary epithelial cells subjected to similar treatments. Omission of l-arginine, Leu, Met, or all of the EAA reduced (P < 0.05) the phosphorylated-to-total signaling ratio of mTOR (Ser2448) and ribosomal protein S6 (rpS6; Ser235/236) in primary bovine mammary epithelial cells. Omission of Leu, Met, and Phe influenced fat synthesis in the primary mammary epithelial cells. Understanding the link between AA and fat synthesis in the mammary gland has practical application in formulating diets to enhance milk fat production.

Key Words: amino acid, fatty acid, milk fat

122 Modeling milk protein yield responses to amino acid supply of dairy cows fed silage-based diets. A. Vanhatalo1, T. Kokkonen1, and P. Huhtanen2, 1University of Helsinki, Helsinki, Finland, 2Swedish University of Agricultural Sciences, Umeå, Sweden.

Production responses to changes in nutrient supply in dairy cows can be predicted with a reasonably accuracy from a large data set of milk production studies using a mixed model regression analysis. In this study, we extended this approach to a level of using individual AA supply for predicting milk protein yield (MPY). Our hypothesis was that the predictions of MPY could be improved by including the supply of individual AA supply compared with the basal model based on ME and Feed-MP supply. Treatment mean data were collected from feeding trials with cows fed silage-based diets supplemented with concentrates. The total data set included 1102 diets in 246 studies. The ME and MP supplies were calculated according to the Finnish system. For calculating the individual AA supply from RUP, the AA profiles were adopted

Key Words: dairy cattle, respiratory chain, gluconeogenesis

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from tabulated values. Microbial AA profile was derived from studies in dairy cows fed silage-based diets. PROC MIXED of SAS was used to develop models predicting MPY. Linear and quadratic effects of the supply of individual AA (g/kg MP or g/kg EAA) were included in the basal model with ME intake and supply of Feed-MP as independent variables. Variation in estimated supply of AA was small (mean CV 2.3% for EAA/MP). The basal model predicted MPY well with adjusted root mean squared error 16.8 g/d. Individual AA (g/kg MP) only marginally improved predictions. The effect was significant for Arg ($P < 0.01$), His ($P = 0.04$) and Leu ($P < 0.001$), but quantitatively the effects were small. Quadratic effects were significant for Leu and Met with maximum MPY at 79 and 25 g/kg MP, respectively. The effects of Ile, Thr and Val were negative ($P < 0.01$) when included as a second AA with Leu. When AA were expressed as g/kg EAA Arg ($P < 0.01$) and Leu had positive ($P < 0.001$) effects on MPY, whereas the effects of Ile, Thr and Val were negative ($P < 0.001$). Quadratic effects were significant for Leu and Met with maximum MPY at 174 and 53 g/kg EAA, respectively. The models imply that potential for increasing MPY of cows fed silage-based diets is small reflecting balanced AA profile from microbial protein and RUP.

**Key Words:** milk protein yield, amino acid supply, modeling

### 123 Effects of oscillating dietary crude protein concentration on production in lactating cows. A. W. Tebea and W. P. Weiss,
Ohio Agricultural Research and Development Center; The Ohio State University, Wooster, OH.

Oscillating the dietary crude protein (CP) from adequate to deficient levels compared with continuously feeding adequate CP has increased N use efficiency in sheep and beef cattle. We hypothesized oscillating dietary CP to dairy cows could maintain milk protein production while feeding a lower average dietary CP content. Our objective was to determine whether oscillating CP content of a diet marginally deficient in metabolizable protein compared with feeding a constant CP concentration alters milk production and N utilization. Thirty Holstein cows (119 ± 21 DIM) were used in a randomized block experiment with a 10-d covariate period and a 50-d treatment period. Diets were adequate CP fed continuously (CP+, 16.2% CP of DM); marginally deficient CP fed continuously (CP−; 14.1% CP); or 24-h oscillations from adequate (16.2% CP) to deficient CP (11.9% CP) to be on average equal to CP− (OSC). Data were analyzed with a mixed model with fixed effects of diet, week, the interaction and random effects of block and block by diet. Compared with CP−, dry matter intake tended to be lower for OSC (23.2 vs. 22.2 kg/d; $P < 0.11$) but similar to CP+ (22.9 kg/d; $P < 0.59$). Milk yield was greater for CP+ compared with CP− (36.6 vs 35.1 kg/d; $P < 0.02$) and similar between CP− and OSC (35.3 kg/d; $P < 0.78$). Milk protein yield was similar among treatments (avg. 1.07 kg/d; $P ≥ 0.14$). Milk urea-N (MUN) was higher for CP+ (12.8 mg/dL; $P < 0.01$) and tended to be higher for OSC (10.9 mg/dL; $P < 0.10$) compared with CP− (10.2 mg/dL). Higher average MUN for OSC could be from enhanced urea recycling. Cyclical patterns in milk and protein yields and MUN occurred with OSC. On days cows received adequate CP, milk and milk protein yields and MUN were lower ($P ≤ 0.04$) compared with days cows received deficient CP (milk: 34.6 vs. 36.1 kg/d; protein: 1.00 vs. 1.05 kg/d; MUN: 9.3 vs 12.5 mg/dL), which indicates production lagged 1 d in response to changes in dietary CP. Overall, the results suggest oscillating CP may improve N utilization through enhanced urea recycling, but additional nutrients may be needed to compensate for reduced intake and to enhance production.

**Key Words:** oscillating protein, nitrogen utilization

### 124 Histidine dose-response effects on lactational performance and plasma amino acid concentrations in lactating dairy cows. S. E. Räisänen*1, C. F. A. Lage*1,2, J. Oh1, A. Melgar1, K. Nedelkov1,2, X. Chen1, M. Miura3, C. Parys4, and A. N. Hristov1,
The Pennsylvania State University, University Park, PA, 2Universidade federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil, 3The Pennsylvania State University, University Park, PA, 4University of Ulster, Belfast, UK, 5Ajinomoto Co, Inc., Kawasaki, Japan, 6Evonik Nutrition & Care GmbH, Hanau-Wolfgang, Germany.

The objective of this experiment was to determine the effect of increasing histidine (His) doses on milk production, milk composition and plasma amino acid (AA) concentrations in lactating dairy cows fed a diet that meets or exceeds their energy and metabolizable protein (MP) requirements. Sixteen Holstein cows [72 ± 15 d in milk, 46.7 ± 7.8 kg milk yield (MY)] were used in a replicated 4 × 4 Latin square design experiment with 4, 28-d periods. The targetted treatments were: (1) total mixed ration (TMR) with 1.8% digestible (d)His of MP, (2) TMR with 2.2% dHis (His2.2), (3) His2.2 supplemented with rumen-protected (RP)His to supply 2.6% dHis, and (4) His2.2 supplemented with RPHis to supply 3.0% dHIs of MP. The actual dHis intakes were 1.83, 2.27, 2.95, and 3.2% dHIs of MP, respectively. The diets supplied similar MP (2,695 ± 422 g/cow/d) and other nutrients, except dHis. Dry matter intake (DMI) and MY were recorded daily, and milk and blood sampling was performed on the last wk of each period. All data were analyzed using PROC MIXED of SAS with period and period × treatment in the model. Square and cow within square were random effects and DMI and MY were analyzed as repeated measures with ar(1) covariance structure. Linear and quadratic effects of His inclusion rate were tested. DMI was not affected by His dose ($P = 0.52$; averaging 23.4 kg/d; SEM = 1.42). There was a quadratic tendency for increased MY ($P = 0.08$; 41.5, 42.7, 43.3, and 42.3 kg/d, respectively). Lactose concentration ($P < 0.01$; quadratic effect) and yield ($P < 0.001$; linear effect) were increased by His. Milk true protein concentration was lower ($P < 0.02$) for His2.2 compared with all other treatments. True protein yield and milk fat concentration and yield were not affected ($P ≥ 0.10$) by treatment. Plasma concentration of His increased quadratically ($P < 0.001$) by His supplementation, as did Lys ($P < 0.01$) and the branched-chain AA ($P < 0.02$). In the conditions of this experiment, lactational performance of dairy cows fed a MP-adequate diet was optimized at dHis supply of 80 g/d, or 2.95% of MP.

**Key Words:** histidine, milk production, plasma amino acid

### 125 Effects of soybean meals versus canola meal on the lactational performance, enteric gas emission, and plasma amino acid profile in dairy cows. C. F. A. Lage*1,2, S. E. Räisänen1, A. Melgar1, X. Chen1, J. Oh1, D. M. Kniffen4, R. A. Fabin5, M. E. Young1, and A. N. Hristov1,
The Pennsylvania State University, University Park, PA, 2Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil, 3College of Pastoral Agriculture Science and Technology, Lanzhou University, China, 4Fabin Bros. Farms, Indiana, PA.

This study investigated the effects of feeding solvent-extracted soybean meal (SSBM), canola meal (CM), or extruded soybean meal (ESBM) on an equivalent crude protein (CP) basis on lactational performance, enteric gas emission and plasma AA profile in dairy cows. Fifteen Holstein cows [95 (SD = 20) days in milk] were used in a replicated 3 × 3 Latin square design experiment with 3, 28-d periods. The diets contained (DM basis): 13.6% SSBM (52% CP, 67.8% ruminal degradability, RDP), 14.2% ESBM (49% CP, 43.7% RDP), or 17.1% CM (40.7% CP, 41.5% RDP). The diets met or exceeded the nutrient requirements of the cows for net energy of lactation and metabolizable protein. Veg-
etable oil (canola oil for CM or soybean oil for SSBM) was added to equalize the ether extract of the diets. Rumen-protected Met was used to ensure a digestible Met supply of 2.2% of MP in all diets. Data were analyzed using the MIXED procedure of SAS as repeated measures with the ar(1) covariance structure and square and cow within square as random effects. CM increased \((P < 0.001)\) dry matter intake (DMI; 26.9 kg/d; SEM = 0.82) compared with ESBM and SSBM (25.3 and 24.5 kg/d, respectively). CM and ESBM increased \((P = 0.002)\) milk yield (43.8 and 42.6 kg/d; SEM = 1.82) compared with SSBM (41.1 kg/d). Treatment did not affect milk composition or feed efficiency \((P > 0.05)\). Milk urea N concentration was lowest \((P < 0.001)\) in CM, followed by SSBM and was highest for ESBM. Compared with CM and SSBM, ESBM increased \((P \leq 0.003)\) plasma concentrations of Ile, Leu, Val, and the sum of EAA and decreased \((P < 0.001)\) Met and Cys. Animals fed CM produced less \((P = 0.008)\) enteric methane per kg of DMI (15.0 g/kg) than both ESBM (16.9 g/kg) and SSBM (17.0 g/kg), but methane emission intensity was similar \((P = 0.14)\) among treatments (average 9.9 g/kg energy-corrected milk; SEM = 0.60). In summary, data suggest that substitution of soybean meals with CM, on an equal CP basis, may enhance DMI. The substitution of SSBM with ESBM or CM may enhance lactational performance in dairy cows.

Key Words: soybean meal, canola meal, dairy cattle