507  Determining immune-modulating components of Saccha-
romyces cerevisiae with RAW 264.7 murine macrophages. S. E.
Sivinski*, R. A. Rusk, J. L. McGill, and B. J. Bradford, Kansas State
University, Manhattan, KS.

Feed components can modulate the immune system, but in vivo data
are expensive and rare; thus, an effective screening tool for evaluat-
ing such nutrients is needed to enable informed selection of candidate
immunomodulators for in vivo investigation. This study used RAW
264.7 murine macrophages as an innate immunity in vitro screening
tool to identify immune-modulating properties of S. cerevisiae
and some of its components. Treatments were 0.01, 0.1, or 1 mg/mL
of whole S. cerevisiae cells (WC), mannan, Zymosan, or β-mannose
at either pH 3 or 7. A pH of 3 was used to mimic the acidic conditions
of the stomach to assess potential alterations of component activity.
The cells were transfected with a vector that drove expression of an alkaline
phosphatase reporter gene upon activation of NFκB. Cells (n = 6 wells/
treatment) were treated with incubations for 18 h. Cell supernatants
were then incubated for 2 h with alkaline phosphatase (AP) substrate
media (QUANTI-Blue) to assay enzyme activity. After normalizing
values across plates using unstimulated and LPS (1 µg/mL) stimulated
cells as negative and positive controls, intra- and inter-assay CVs were
3.9% and 15.8%. The effects of treatment, pH, and dose (treatment) were
evaluated by mixed models. Treatment and dose (treatment) affected AP
activity (both P < 0.001) whereas pH did not (P = 0.31). Mannan at 0.1
mg/mL and WC at 1 mg/mL tended to increase AP activity (both P =
0.07), while mannan and β-mannose at 1 mg/mL, WC at 0.1 mg/mL,
and Zymosan at 1, 0.1, and 0.01 mg/mL increased AP activity (0.10 ±
0.02, 0.09 ± 0.02, 0.10 ± 0.02, 1.85 ± 0.04, 1.62 ± 0.04, and 0.78 ± 0.03
OD, respectively; all P < 0.001), compared with unstimulated cells.
Zymosan increased AP activity vs. mannan, WC, and β-mannose (1.37
± 0.02 vs. 0.05 ± 0.01, 0.05 ± 0.01, and 0.03 ± 0.01 OD, respectively;
all P < 0.001), and WC stimulated a greater response than β-mannose
(0.05 ± 0.01 vs. 0.03 ± 0.01 OD; P = 0.03). Overall, this innate immunity
in vitro screening method was useful for quickly determining immune-
modulating properties and concentrations of S. cerevisiae components.

Key Words: bioactive nutrient, nutritional immunology, in vitro
screening method

508  Long-term effects of reduced-fat distillers grains with and
without monensin on performance of dairy cows. D. L. Morris*1,
S. H. Kim1, P. J. Kononoff2, and C. Lee1, 1Department of Animal
Sciences, Ohio Agricultural Research and Development Center, The
Ohio State University, Wooster; OH, 2Department of Animal Science,
University of Nebraska, Lincoln, NE.

This study investigated the long-term effects of high inclusion of
reduced-fat corn distillers grains with solubles (RFDG) with and without
monensin on intake, production, milk fatty acid profile, and plasma
AA profile in lactating cows. The experiment was conducted for 11 wk
(2-wk diet adaptation, 9-wk experimental period of data collection)
with 36 Holstein cows (80 ± 31 DIM; mean ± SD at start of trial) in a
randomized block design. Cows were blocked by parity and DIM and
assigned to the following diets: (1) CON, control diet; (2) DG, CON
with RFDG included at 28.8% (dry matter basis) replacing soybean
meal, soyhulls, and supplemental fat; (3) DGMon, DG with monensin
(Rumensin; Elanco Animal Health, Greenfield, IN) supplemented at a
rate of 20 mg/kg of DM. Data were analyzed with a model that included
the fixed effect of treatment, week, and interaction of diet and week,
the random effect of cow within block, repeated measures were
included. Orthogonal contrasts were used to compare CON vs. DG and
DGMon and DG vs. DGMon. Milk yield was not affected (40.3 vs. 40.8
kg/d; P = 0.58) by DG and DGMon compared with CON. However, dry
matter intake (DMI; 24.9 vs. 26.4 kg/d), milk fat yield (1.12 vs. 1.55
kg/d), milk protein yield (1.24 vs. 1.32 kg/d), and energy-corrected milk
yield (37.7 vs. 43.5 kg/d) decreased (P < 0.01) for DG and DGMon
compared with CON. Feeding DGMon compared with DG did not affect
(DG ≥ 0.102) DMI (24.4 vs. 25.4 kg/d) and milk yield (39.2 vs. 41.3 kg/d),
but decreased (P ≤ 0.02) milk fat yield (1.08 vs. 1.23 kg/d), milk protein
yield (1.20 vs. 1.28 kg/d), and energy-corrected milk yield (36.0 vs. 39.4
kg/d). Interactions between treatment and wk (P ≤ 0.08) for DMI, milk
fat yield, and energy-corrected milk indicate production responses to
DG and DGMon vs. CON were decreased over the experimental period.
In the current study, feeding a high-DG diet did not sustain long-term
DMI and production, and supplementing monensin to a high-DG diet
further decreased DMI and production.

Key Words: reduced-fat distillers grains, monensin, performance
These results demonstrate that corn stover-based pellets with SBM or DG can replace pelleted corn gluten feed with limitations on DMI and milk yield but sustained FCM production efficiency.

**Key Words:** by-products, crop residue, corn stalks

510 Production effects of extruded soybean meal in early lactation cow diets. M. T. Harper*1, J. Oh1, A. Melgar2, K. Nedelkov2, S. Räisänen1, X. Chen1, C. M. M. R. Martins3, M. Young1, T. Ott1, D. M. Knill1, R. Fabian1, and A. N. Hristov1, 1The Pennsylvania State University, University Park, PA, 2Trakia University, Stara Zagora, Bulgaria, 3College of Pastoral Agriculture Science and Technology, Lanzhou University, Gansu, China, 4School of Veterinary Medicine and Animal Science, University of Sao Paulo, Pirassununga, Brazil, 5Fabin Bros. Farms, Indiana, PA.

The objective of this experiment was to evaluate the productive and reproductive effects of replacing solvent extracted soybean meal (SSBM) with extruded soybean meal (ESBM) in a total ration diet for early lactation cows. Thirty-four Holstein cows (12 primiparous and 22 multiparous) were used in a randomized complete block design. The Pennsylvania State University, University Park, PA, and Animal Science, University of Sao Paulo, Pirassununga, Brazil, were enrolled in a multiple 5 × 5 Latin square design with 21-d periods with different sources and processing of protein feedstuffs on lactation feed costs and partially replace a variety of concentrate feeds in dairy cow diets. Corn stover treated with alkaline and pelleted with protein may lower feed costs and partially replace a variety of concentrate feeds in dairy cow diets. The objective was to evaluate treated corn stover pelleted with different sources and processing of protein feedstuffs on lactation performance and rumen characteristics. Twenty lactating Holstein cows were enrolled in a multiple 5 × 5 Latin square design with 21-d periods and randomly assigned to 1 of 5 treatments: (1) control diet with no pellets (CON), (2) treated corn stover with extrusion processed soybean meal pellets, (3) treated corn stover with unprocessed soybean meal pellets, (4) treated corn stover with extrusion processed dried distillers grains with solubles pellets, and (5) treated corn stover with unprocessed dried distillers grains with solubles pellets. All diets were formulated to contain 53.5% forage and 46.5% concentrate (DM basis). For pellet diets, inclusion rate was maintained at 20% (DM basis) and replaced 40% ground corn, 32.5% canola meal, 25% soybean hulls, and 2.5% limestone. Data were analyzed using the MIXED procedure of SAS.

Dry matter intake (DMI) was greater (P < 0.001) for cows fed CON diet (30.8 kg/d) than cows fed pellet diets (27.1, 26.4, 26.2, 26.5 kg/d). Cows fed CON diet were greater (P < 0.001) in milk yield compared with cows fed pellet diets (47.5 vs. 42.4, 42.7, 43.0, 42.8 kg/d). However, DMI and milk yield did not differ for cows fed the pellet diets (P > 0.10). Milk fat and lactose percentages were unaffected (P > 0.10) across all 5 treatments, while cows fed CON diet produced greater milk protein percentage than cows fed pellet diets (P < 0.001). Feed efficiency (energy-corrected milk/DMI) tended (P = 0.08) to increase for cows fed pellet diets compared with cows fed CON diet. There were no differences in total ruminal VFA for cows fed CON vs pellet diets (P > 0.10); however, protein processing decreased ruminal acetate and increased propionate percentages (P < 0.01). At 20% inclusion rate in the diet, there does not appear to be an advantage of one pellet over the other in terms of performance.

**Key Words:** treated corn stover, pellet, protein

512 Quantifying the effects of amino acid profile, energy supply, and diet nutrient composition on the requirement of metabolizable protein by lactating dairy cows. L. E. Moraes*1, J. L. Firkins1, H. Lapierre2, E. Kebreb3, and R. R. White4, 1The Ohio State University, Columbus, OH, 2Agriculture and Agri-Food Canada, Sherbrooke, QC, Canada, 3University of California, Davis, CA, 4Virginia Tech, Blacksburg, VA.

The objective of this study was to quantify and characterize the effects of amino acid profile, energy supply and covariates describing diet nutrient composition and cow’s physiological status on the efficiency of utilizing metabolizable protein (MP) and on the combined MP requirement for maintenance and lactation. A Bayesian hierarchical modeling approach was used to model the total true protein export (PE, milk + scurf + metabolic fecal protein) as a function of the net MP supply (digestible microbial protein + digestible RUP – endogenous urinary protein) using 333 treatment means from 87 publications. The nonlinear model was constructed with a logistic function and heterogeneous error variances were modeled proportionally to the SE of the milk protein yield means. A regression of the predicted study-specific logistic parameters on the amino acid profile (expressed as % of total essential AA supply), DE intake (DEI), diet content of fatty acids, starch, cow’s body weight and DIM was used to explain the between study variation and quantify the effects of these covariates. The combined MP requirement was defined as the MP needed to predict a given PE in the fitted model. Thus, an effect of any covariate in the functional parameters of the fitted model had a direct effect on the efficiency of utilizing MP as well as on the combined MP requirement. Lysine, Met, His, Val, Phe, and Thr significantly affected the efficiency and the MP requirement (P < 0.05). Likewise, metabolic body weight, DIM as well as diet concentrations of starch, fatty acids, and DEI all affected the protein export, efficiency, and the MP requirement (P < 0.05). The model allows assessment of impact of changing the AA profile, diet and varying cow’s physiological status on metabolism in light of the present data.
the combined MP requirement. For example, the effect of DEI was larger at greater MP supplies and protein exports. At a net MP supply of 3 kg/d, a 5 Mcal increase in DEI predicted an increase of 36 g in the protein export. Likewise, at a PE of 1 kg, a 5 Mcal increase in DEI reduced the requirement for net MP by 54 g.

Key Words: nonlinear, protein, requirement

513 Quantifying the variation in resilience to protein-deficient diets in lactating dairy cows. E. Liu* and M. J. VandeHaar, Michigan State University, East Lansing, MI.

Diets with less protein improve profitability unless the savings from feeding less protein are outweighed by lost milk revenue. Our objective was to quantify the variation among cows in their ability to maintain production (be resilient) when fed protein-deficient diets. Mid-lactation Holstein cows with initial energy-corrected milk (ECM) of 40 ± 9 kg/d (n = 149, in 5 blocks) were fed either a high protein diet (18% CP; HP) or low protein diet (14%CP; LP) in a crossover design with 2 treatment periods of at least 28 d/period. Both diets contained at least 9.8% rumen-degraded protein. HP and LP diets were similar for each block, but HP contained expeller soybean meal that was replaced by soybean hulls and ground corn in LP. HP contained 4% units more CP, 2% units less starch, and 2% units less NDF than LP. Cows were fed ad libitum. Fixed effects of block, parity, diet, period, cohort, and cohort by diet, and random effect of cow were included in the model to examine milk output and total capture of energy and protein (assuming body energy gain = 6 × BW gain/day and body protein gain = 0.14 × BW gain/day) between diets. Compared with LP, HP increased ECM (39.4 vs. 35.4 kg/d; P < 0.01), milk protein (1.28 vs. 1.14 kg/d; P < 0.01), BW gain (0.47 vs. 0.11 kg/d; P < 0.01), MUN (15.1 vs. 9.3 mg/dL; P < 0.01), captured energy (32.4 vs. 27.2 Mcal/d; P < 0.01), and captured protein (1.35 vs. 1.15 kg/d; P < 0.01). Decreases in milk and captured energy and protein for each cow when fed LP compared with HP were calculated and modeled by ECM as a linear function. The residual term from the prediction model was used to quantify variation among cows for resilience to LP. The R², means, and standard deviations (SD) of means and residuals were, respectively, (1) 0.74, 4.0, and 3.2 kg for ECM; (2) 0.80, 0.14, 0.10, and 0.05 for kg milk protein; (3) 0.60, 5.0, 5.5, and 3.5 for Mcal captured energy; and (4) 0.67, 0.17, 0.16 and 0.09 for kg captured protein. We conclude that half of the variation remains for the residual term and suggest that genetics contributes to part of this variation.

Key Words: dairy cow, variation, protein-deficient diet

514 Feeding incremental amounts of rumen-protected histidine to lactating dairy cows. Y. Zang*1, L. H. P. Silva2, M. G. Khan1, A. F. Brito1, and M. Miura3, 1University of New Hampshire, Durham, NH, 2Federal University of Viçosa, MG, Brazil, 3Ajinomoto Co. Inc., Kawasaki-shi, Japan.

The dairy industry can benefit from the use of low crude protein (CP) diets due to improved N efficiency. However, His could become limiting in CP-deficient diets. Therefore, our objective was to evaluate the effect of rumen protected (RP)-His on production, and N and AA metabolism in dairy cows. Eight multiparous Holstein cows (130 ± 30 DIM, 42 ± 2 kg/d milk) were used in a replicated 4 × 4 Latin square design with 28-d experimental periods. Treatments included a basal diet composed (DM basis) of 50% corn silage, 15% haylage, and 35% concentrate supplemented with 0.82, 164, and 246 g/d RP-His (Ajinomoto Inc.) and 11 g/d RP-Met (Smartamine M). Dietary His represented 2.06, 2.28, 2.52, and 2.75% of MP supply, respectively. Milk samples were collected in the last 2 wk of each period, with blood, urine (spot), and muscle samples in wk 4. Data were analyzed with the MIXED procedure of SAS, evaluating treatment effects with linear and quadratic contrasts. Treatments had no effect on DMI and milk composition. In contrast, yields of milk (30.8 to 32.9 kg/d; P = 0.01) and milk true protein (0.92 to 0.99 kg/d; P < 0.01) increased linearly, while milk fat yield (1.23 to 1.30 kg/d; P = 0.06) tended to increase linearly with RP-His. Plasma His (33.2 to 63.1 μM; P < 0.001) and carnosine (29.3 to 33.5 μM; P = 0.03), as well as muscle His (20.3 to 35.5 μM; P < 0.001) showed linear responses to RP-His, whereas no treatment effects were detected for plasma Met and Lys. There were no treatment effects on muscles carnosine and anserine. Milk urea-N (11.7 to 12.9 mg/dL; P = 0.03) and urinary excretion of urea-N (23.7 to 27.0% of N intake; P = 0.04) increased linearly in response to RP-His. Treatments did not affect urinary excretion of uric acid, allantoin, and total purine derivatives. Overall, supplementation with RP-His to a CP-deficient diet improved milk and milk protein synthesis, likely as a result of increased plasma His. Increased milk urea-N and urinary excretion of urea-N suggest that plasma His may have exceeded the requirement with excess deaminated and converted to urea in the liver due to moderate milk production in our study.

Key Words: dairy cow, rumen-protected amino acid, histidine

515 Predicting energy-corrected milk and milk true protein yields using NorFor and the Nutritional Dynamics System version of the Cornell Model. G. A. Broderick*1, M. Åkerlind2, N. I. Nielsen1, and P. Nordgren2, 1Broderick Nutrition & Research LLC, Madison, WI, 2Broderick Nutrition & Research LLC, Växa Sverige, Uppsala, Sweden, 3SEGES, Aarhus N, Denmark.

Table 1 (Abstr. 515). Linear regression parameters from fitting NorFor and NDS predictions to observed ECM and MTP yields

<table>
<thead>
<tr>
<th>Trait</th>
<th>Model</th>
<th>R²</th>
<th>RMSE¹</th>
<th>Intercept</th>
<th>SE²</th>
<th>Prob²</th>
<th>Slope</th>
<th>SE</th>
<th>Prob³</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECM</td>
<td>NorFor</td>
<td>0.914</td>
<td>0.787</td>
<td>6.3</td>
<td>3.4</td>
<td>0.078</td>
<td>0.80</td>
<td>0.09</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>NDS</td>
<td>0.855</td>
<td>2.168</td>
<td>−22.7</td>
<td>9.2</td>
<td>0.027</td>
<td>1.69</td>
<td>0.25</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MTP</td>
<td>NorFor</td>
<td>0.920</td>
<td>0.027</td>
<td>0.19</td>
<td>0.10</td>
<td>0.068</td>
<td>0.78</td>
<td>0.08</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>NDS</td>
<td>0.788</td>
<td>0.077</td>
<td>−0.36</td>
<td>0.28</td>
<td>0.226</td>
<td>1.30</td>
<td>0.23</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

¹Root mean square error and standard error.
²Probability that intercept is different from 0.
³Probability that slope is different from 1.
The NorFor nutrition model (http://www.norfor.info/) has been used extensively for formulating dairy rations in Scandinavia. The Nutritional Dynamics System (NDS) version of the Cornell model (http://www.rumen.it/en/ndspro) has been widely adopted by consulting nutritionists in North America. We initiated a comparison of how well NorFor and NDS predicted observed yields of energy-corrected milk (ECM) and milk true protein (MTP). Data from 5 published trials (21 diets) were entered into NorFor (version 2017.12.0.187) and NDS (version 3.9.5.01). Analyzed composition data for major feed ingredients were used to modify tabulated feed compositions in both models. NorFor reports ECM directly but total milk protein rather than MTP; MTP was computed by multiplying total milk protein by 0.95. The lower of the energy- or MP-allowable ECM and energy- or MP-allowable MTP reported by NDS were used in fitting. Data were from short-term Latin square trials; thus, yields were not corrected for BW change in either model. Predictions of ECM and MTP were regressed on observed data using SAS, including trial and diet(within trial) in the general linear model; regression parameters are in Table 1. Both models explained most of the observed variation; however, root mean square errors were smaller and coefficients of determination were greater when fitting NorFor data. Moreover, standard errors of intercepts and slopes were smaller for NorFor. Slopes from fitting ECM and MTP predictions from both models were different from 1, indicating significant slope bias. Further work using much larger databases is needed to test the relative effectiveness of the NorFor and NDS models.

Key Words: NorFor, Nutritional Dynamics System, Cornell model

516 Insulin is required for essential amino acid stimulation of mTORC1 signaling in mammary cells. V. L. Pszczolkowski*, M. M. Kurth, E. Meyer, and S. I. Arriola Apelo, Department of Dairy Science, University of Wisconsin-Madison, Madison, WI.

Insulin stimulates milk protein synthesis through repression of tuberous sclerosis protein complex and recruitment of the mechanistic target of rapamycin complex 1 (mTORC1) to the lysosomal membrane, where mTORC1 can be activated by AA. We analyzed the necessity of insulin signaling for essential AA (EAA) stimulation of mTORC1 substrates in mammary epithelial cells. MAC-T cells (n = 3) were serum and insulin starved overnight and further starved for EAA for 4 h before incubating for 1 h in Dulbecco’s modified Eagle’s medium supplemented with insulin (100 nM) or vehicle, and 0, 0.05, 0.1, 0.3, 1.0, and 3.0 mM of EAA at the profile of casein. Nonessential AA were maintained at 1.2 mM. Intracellular proteins were isolated and analyzed by Western blotting for total and phosphorylated forms of the mTORC1 substrate and protein synthesis regulator S6 kinase 1 (Thr 389), its downstream substrate ribosomal protein S6 (Ser 240/244), and the mTORC1 substrate and autophagy initiator factor ULK1 (Ser 757). Amino acid dose response parameters (linear and quadratic) were estimated for the phosphorylated to total ratio of each of the above-mentioned proteins, using the linear model and confidence interval functions in RStudio. Amino acid response parameters were estimated independently in the presence and absence of insulin. Intercepts were higher in the presence of insulin, from 70% for ULK1 to 10-fold for S6K1, indicating an AA-independent effect of insulin on mTORC1 activity. On the other hand, essential AA significantly stimulated mTORC1 activity only in the presence of insulin, where linear and quadratic parameters for the 3 target proteins were significantly different than zero (P < 0.01). In the absence of insulin, linear and quadratic parameter estimates were no different than zero (P > 0.05), but significantly different than insulin-treated parameter (P < 0.05). Our results indicate that EAA have insulin-independent saturable effects on mTORC1 activity within physiological levels, suggesting that disruption of insulin signaling would negatively affect milk protein synthesis.

Key Words: insulin, amino acids, mechanistic target of rapamycin (mTOR)

517 Assessing bioavailability of amino acids from various feedstuffs in dairy cattle using a stable isotope–based approach. X. Huang1, K. A. Estes2, P. S. Yoder1, and M. D. Hanigan1, 1Virginia Polytechnic Institute and State University, Blacksburg, VA, 2Balchem Corp., New Hampton, NY.

Improving N efficiency can be achieved in dairy cows by more precisely supplying amino acids (AA) relative to requirements which necessitates accurate supply estimates of individual amino acids from feedstuffs. This study was conducted to determine absorption of individual AA from various feedstuffs. Seven heifers (258 ± 28 kg BW) were assigned to 8 treatment sequences in a 7 × 8, incomplete, Latin square design. Treatments were a control base diet (BD) plus 10% (DM basis) corn silage (CS), grass hay (GH), alfalfa hay (AH), soybean hulls (SH), dried distiller grains (DDGS), wet brewer grains (BG), or corn grain (CG). Each period was 10 d. The base diet contained a mix of corn silage, dry hay, and soybean meal. The crude protein content for AH, BD, BG, CG, CS, DDGS, GH, and SH diets were 22.5, 23.1, 23.3, 21.8, 21.8, 23.5, 22.0, and 22.1% respectively. Blood AA entry rates were estimated for each AA by fitting a 4-pool dynamic model to blood 13C AA enrichment over the course of a 2h 13C algal AA infusion. Dry matter intake tended to be lower for BG diet (P = 0.072) and N intake was lower for CG, CS and GH diets (P < 0.01). Apparent total-tract N digestibility was 64.7 ± 4.6%, without significant difference among treatments. The plasma entry rates of Ile, Leu, Lys, Met, Phe, Thr, and Val were 5.61, 5.99, 5.90, 5.74, 5.61, 5.83, 5.76, and 5.87 mmol/min for AH, BD, BG, CG, CS, DDGS, GH, and SH, respectively. Blood AA entry rates were estimated for each AA by fitting a 4-pool dynamic model to blood 13C AA enrichment over the course of a 2h 13C algal AA infusion. Dry matter intake tended to be lower for BG diet (P = 0.072) and N intake was lower for CG, CS and GH diets (P < 0.01). Apparent total-tract N digestibility was 64.7 ± 4.6%, without significant difference among treatments. The plasma entry rates of Ile, Leu, Lys, Met, Phe, Thr, and Val were 5.61, 5.99, 5.90, 5.74, 5.61, 5.83, 5.76, and 5.87 mmol/min for AH, BD, BG, CG, CS, DDGS, GH, and SH, respectively, and no significant difference was detected among treatments. For nonessential AA (Ala, Asp, Pro, Tyr, Glu, Gly), the plasma entry rates were 14.00, 14.84, 15.18, 15.25, 14.31, 17.51, 13.56, and 14.20 mmol/min for AH, BD, BG, CG, CS, DDGS, GH, and SH, respectively, and no significant difference was detected among treatments. For nonessential AA (Ala, Asp, Pro, Tyr, Glu, Gly), the plasma entry rates were 14.00, 14.84, 15.18, 15.25, 14.31, 17.51, 13.56, and 14.20 mmol/min for AH, BD, BG, CG, CS, DDGS, GH, and SH, respectively, and DDGS had trend to be higher (P = 0.075). Given the derived AA plasma entry rates, the individual AA supply by ingredient can be determined by regression in future work.

Key Words: amino acids, bioavailability, dairy cattle