Determination of the bioavailability of lysine in a rumen-protected lysine product exposed to TMR using the in vivo plasma lysine response method

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INTRODUCTION

- Lysine is a limiting amino acid for milk protein synthesis in dairy cows fed corn-based rations
- Dietary inclusion of sources of rumen-protected lysine (RPL) allows for increased accuracy in supplying adequate lysine to lactating cows
- Determining the bioavailability of RPL products using the slope ratio assay technique aids in ranking newly developed products against others already commercially available
- Methods for assessing bioavailability or RPL products should incorporate on-farm feeding practices like exposure to TMR

OBJECTIVES

- Estimate bioavailability of the third generation of RPL product, AjiPro®-L 3G using the previous generation AjiPro®-L 2G (Ajinomoto Heartland, Inc.) after products were exposed to TMR

MATERIALS AND METHODS

- Fourteen multiparous Holstein cows, housed in tie stalls, averaging 114 ± 8 (mean ± SD) DIM, 709 ± 74 kg of BW, and 2.9 ± 0.3 lactations were used in a replicated 7 x 7 Latin square design with 7-d periods
- A common basal diet (TMR) adequate in Lys was prepared 1x/d and fed proportionately: 33.4% at 0500 h, 33.3% at 1300 h and 33.3% at 2100 h
- Experimental treatments supplemented (per 27 kg/d DM offered) the TMR on d 2 through 7 of each period and included:
  1) 0 g/d Lys (Control)
  2) 30 g/d Lys (75.0 g/d AjiPro®-L 2G)
  3) 45 g/d Lys (112.5 g/d AjiPro®-L 2G)
  4) 60 g/d Lys (150.0 g/d AjiPro®-L 2G)
  5) 30 g/d Lys (75.0 g/d AjiPro®-L 3G)
  6) 45 g/d Lys (112.5 g/d AjiPro®-L 3G)
  7) 60 g/d Lys (150.0 g/d AjiPro®-L 3G)

- To simulate on-farm exposure of RPL products to TMR, products were mixed with small amount of TMR once daily then fed 15 minutes prior to each TMR feeding
- BW and BCS were assessed at beginning and end of each period, milk yield and DMI were determined on d 2 through 7, and milk composition measured on d 6 and 7
- Four blood samples were taken at 2-h intervals (0600 to 1200 h) on d 6 and 7 of each period, pooled by cow within day, stored at -80°C, and blindly analyzed for AA composition using UPLC/MS (Waters Corporation, Milford, MA)

STATISTICAL ANALYSIS

- Data collected over time were reduced to a period mean per cow and analyzed using the MIXED procedure of SAS (version 9.4)
- The UNIVARIATE procedure of SAS was used to determine if plasma lysine observations within cow and supplemented lysine level could be considered outliers
- The REG procedure of SAS was used to generate linear regression models for each individual cow supplemented AjiPro®-L 2G and AjiPro®-L 3G using the values of lysine as a % of total amino acids (TAA; µmol)
- Resultant slope values were averaged by product and relative estimated bioavailability of AjiPro®-L 3G was determined following the procedures of Littell et al. (1997)

RESULTS

Table 1. Characterization of RPL products

RPL Product	Lys Compound	Coating Material	Lys, % DM
AjiPro®-L 2G	L-Lys-HCl	Vegetable Oil	40.20
AjiPro®-L 3G	L-Lys-HCl	Vegetable Oil	40.46

Table 2. Intake, Lys dose, body weight, and milk production parameters of lactating Holstein cows fed basal diet supplemented with RPL products

	Treatment								
	Control	AjiPro®-L 2G			AjiPro®-L 3G				
Item	0	30	45	60	30	45	60	SE	*P*-value
DMI, kg/d	27.5	27.3	27.0	27.1	27.4	27.3	27.0	0.48	0.13
Dose, g Lys/d	0[d]	33.2[c]	49.7[b]	65.8[a]	33.5[c]	49.7[b]	66.6[a]	0.7	**< 0.01**
BW, kg	711	709	713	716	711	711	712	21.0	0.69
Milk, kg/d	43.9	43.0	44.8	42.9	44.9	44.8	43.6	1.46	0.08
Fat, %	4.23	4.34	4.20	4.30	4.31	4.26	4.19	0.15	0.25
True Prot, %	3.28	3.29	3.20	3.29	3.24	3.18	3.24	0.07	0.10
Urea N, mg/dL	12.90	13.13	12.93	13.07	12.85	12.59	12.77	0.28	0.27

[abcd] Means within a row without a common superscript differ ($P \leq 0.05$)

Table 3. Plasma lysine concentrations of lactating Holstein cows fed a basal diet supplemented with RPL products

	Supplemented lysine, g/d					
Lysine	0	30	45	60	SE	*P*-value
µmol/L						
AjiPro®-L 2G	110.7[b]	118.7[b]	115.9[b]	119.8[a]	3.2	**0.04**
AjiPro®-L 3G		111.9[b]	119.6[ab]	123.8[a]	3.5	**< 0.01**
% of TAA*, µmol/L basis						
AjiPro®-L 2G	4.49[b]	4.78[a]	4.77[a]	4.90[a]	0.09	**< 0.01**
AjiPro®-L 3G		4.63[b]	4.91[a]	5.02[a]	0.09	**< 0.01**

[ab] Means within a row without a common superscript differ ($P \leq 0.05$)
*TAA calculated without Lys

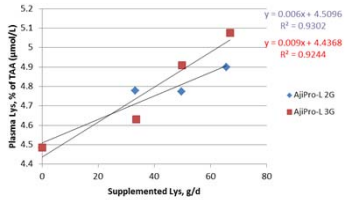

Figure 2. Plasma lysine concentrations (% of TAA, µmol basis) with increasing amounts of supplemented Lys from AjiPro®-L 2G and AjiPro®-L 3G

Table 4. Lysine bioavailability of AjiPro®-L 3G relative to that of AjiPro®-L 2G using changes in plasma Lys concentrations (slope) as the response criteria

	Treatment			
	AjiPro®-L 2G		AjiPro®-L 3G	
Plasma Lys	Slope	SE	Slope	SE
µmol/L	0.1243	0.0207	0.1922	0.0534
%TAA (µmol/L basis)	0.006	0.0008	0.009	0.0012
Lys bioavailability relative to that of AjiPro®-L 2G				
µmol/L			154.63	
%TAA (µmol/L basis)			146.67	

CONCLUSIONS

- Relative bioavailability of AjiPro®-L 3G was 146.7% of the bioavailability of AjiPro®-L 2G when calculated using the in vivo plasma lysine response method
- This is one of the first studies to assess bioavailability of RPL products exposed to TMR to simulate on-farm feeding practice of feed delivery 1x/d