Comparative bioavailability of lysine in three commercially available rumen-protected lysine products using the in vivo plasma lysine response method

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INTRODUCTION

- Lysine (Lys) is a limiting amino acid for milk protein synthesis in dairy cows fed corn-based rations
- Dietary inclusion of sources of rumen-protected Lys allows for increased accuracy in supplying adequate Lys to lactating cows
- Differences in rumen protection, Lys content, and absorption alter the availability of Lys
- Lys bioavailability of second generation AjiPro®-L was determined using the plasma free amino acid dose response technique (Whitehouse et al., 2014)
- Determining the bioavailability of rumen-protected Lys (RPL) products using the slope ratio assay technique aids in comparing newly developed and commercially available RPL products

OBJECTIVES

- Estimate relative bioavailability of two commercially available RPL products: MetaboLys (MBL; H.J. Baker & Bro., Inc., Westport, CT) and USA Lysine (USA; Kemin Industries Inc., Des Moines, IA) using second generation AjiPro®-L (A2G; Ajinomoto Heartland, Inc.) as a standard reference using the slope ratio assay technique
- Evaluate the effect of feeding RPL products (A2G, MBL, and USA) on milk yield, milk composition, and plasma Lys concentration

MATERIALS AND METHODS

- Fourteen multiparous Holstein cows averaging 113 ± 28 (mean ± SD) DIM and 714 ± 56 kg of BW were used in a replicated 7 x 7 Latin square design with 7-d periods
- A common TMR balanced for adequate Lys (6.72% of MP) and methionine (2.29% of MP) was fed at 3 intervals (33.4% at 0500 h, 33.3% at 1300 h and 33.3% at 2100 h)
- Experimental treatments supplemented (per 27 kg/d DMI) a common basal diet on d 2 through 7 of each period and included:
  1) 0 g/d Lys (negative control)
  2) 30 g/d supplemented Lys (75.0 g/d A2G)
  3) 60 g/d supplemented Lys (150.0 g/d A2G)
  4) 30 g/d supplemented Lys (100.0 g/d MBL)
  5) 60 g/d supplemented Lys (200.0 g/d MBL)
  6) 30 g/d supplemented Lys (57.7 g/d USA)
  7) 60 g/d supplemented Lys (115.4 g/d USA)
- Inclusion rates of each RPL product differed to correspond with manufacturer specified L-Lys content: A2G - 40% L-Lys/g; MBL - 30% L-Lys/g; and USA - 52.0% L-Lys/g
- To mimic inclusion of RPL products in the TMR and maintain a constant ratio of RPL to total feed consumed, daily allotted amounts of RPL products were divided proportionally at each of the three feedings
- BW and BCS were assessed on d 1 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 analyzed for plasma 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 9.2)
- The UNIVARIATE procedure of SAS identified no outliers (>2.5 SD of mean) for plasma Lys observations within cow and supplemented Lys level
- The REG procedure of SAS was used to generate linear regression models for each individual cow supplemented A2G, MBL, and USA using plasma Lys as a % of TAA (μmol)
- Relative to A2G, estimated bioavailability of Lys in MBL and USA was determined using slope-ratio assay technique which divided the average slope of MBL and USA by the average slope of A2G (Littell et al., 1997)

RESULTS

Table 1. Dry matter intake, supplemental Lys dose, milk yield, milk composition, and feed efficiency of lactating Holstein cows fed a basal diet with two levels of Lys supplementation from three RPL products

	Treatment								
	Control	A2G		MBL		USA			
Item	0	Low	High	Low	High	Low	High	SE	*P*-value
DMI kg/d	28.0	28.0	27.2	27.2	27.7	27.6	27.6	0.1	0.39
Dose Lys/d	0.0	34.1[a]	66.5[b]	33.1[a]	68.0[b]	33.9[a]	67.1[b]	1.2	<0.01
Milk yield									
Milk, kg/d	51.2	50.9	48.9	48.6	50.6	50.0	51.5	1.8	0.13
3.5% FCM, kg/d	51.2	51.3	50.4	51.1	50.3	51.0	51.6	1.5	0.86
SCM, kg/d	47.1	47.3	47.2	48.1	45.4	47.7	47.9	1.5	0.51
Milk composition									
Fat, kg/d	1.8	1.8	1.9	1.8	1.8	1.8	1.8	0.1	0.59
True protein, kg/d	1.5	1.5	1.5	1.5	1.5	1.6	1.6	0.1	0.42
Lactose, kg/d	2.4	2.4	2.4	2.5	2.3	2.5	2.5	0.1	0.51
Urea N, mg/dL	11.5	11.8	11.5	11.3	12.0	10.9	11.8	0.4	0.28

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

Table 2. Plasma Lys concentrations of lactating Holstein cows fed a basal diet with two levels of Lys supplementation from three RPL products

	Targeted Lys supplementation, g/d				
Plasma Lys	0	30	60	SE	*P*-value
μmol/L					
A2G		102.4	101.6	4.1	0.01
MBL	89.6	92.1	91.7	3.7	0.72
USA		92.4	94.5	4.3	0.32
% of TAA, μmol/L					
A2G		4.14	4.21	0.14	0.01
MBL	3.74	3.79	3.77	0.13	0.87
USA		3.84	3.80	0.15	0.40

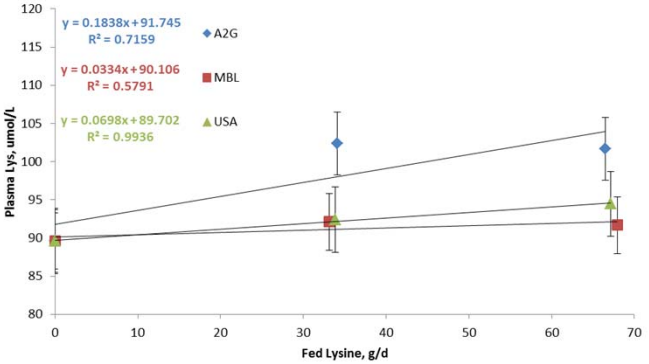

Figure 1. Mean plasma Lys concentrations (μmol/L) of lactating Holstein cows fed a basal diet with two levels of Lys supplementation from three RPL products

Table 3. Mean plasma Lys slopes used from lactating Holstein cows fed three RPL products to calculate bioavailability of Lys in MBL and USA relative to A2G

	RPL Product					
	A2G		MBL		USA	
Plasma Lys Variable	Slope	SE	Slope	SE	Slope	SE
μmol/L	0.1838	0.0425	0.0334	0.0516	0.0698	0.0463
% TAA, μmol/L	0.0079	0.0019	0.0007	0.0015	0.0011	0.0016

	Lys bioavailability relative to A2G (%)		
μmol/L	100.0	18.3	38.2
% TAA, μmol/L	100.0	8.8	14.02

CONCLUSIONS

- As expected, there was no difference in intake and animal performance since the basal diet provided adequate lysine
- Plasma Lys increased ($P = 0.01$) when cows were supplemented with A2G
- Plasma Lys did not significantly increase from basal diet levels regardless of supplemented amount of MBL or USA
- Bioavailability of MBL and USA are 18.3 and 38.2% of the bioavailability of A2G, respectively

REFERENCES

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