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Evaluation of the Bioavailability of USA Lysine® and MetiPEARL™ in Lactating Dairy Cows

USA Lysine® and MetiPEARL™ are manufactured to have a precise specific gravity and particle size leading to rapid transit through the rumen, reducing microbial exposure. The result is that these rumen protected amino acid (RPAA) products combine a high level of rumen escape and intestinal release, which results in bioavailability values that make them cost effective sources of MP lysine and MP methionine.

Bioavailability for a RPAA is commonly evaluated one product at a time. However, in commercial settings it is likely that both rumen protected lysine and methionine (RPL and RPM) would be fed together and trials allowing simultaneous estimates of the bioavailability of multiple amino acid products more closely relate to real world situations. To our knowledge, few such trials have been conducted. The objectives of this study were to evaluate the bioavailability of USA Lysine and MetiPEARL provided together in a lactating cow diet.

Materials and Methods

Five ruminally cannulated, mid lactation, multiparous Holstein cows were used in a 5x5 Latin square study at the University of Delaware (Newark, DE). They averaged 194 days in milk (DIM) and had an average body weight of 755 kg. The cows were moved into a tie-stall facility seven days prior to the start of the study (adaptation period) and fed a ration balanced to contain sufficient MP methionine and lysine (Appendix A and B). Treatments for the study were:

- Control (CON): diet sufficient in MP methionine and lysine plus abomasal infusion of saline.
- Fed Low (FL): control diet plus low levels of USA Lysine (60 g/d) and MetiPEARL (30 g/d) added to the diet.
- Fed High (FH): control diet plus high levels of USA Lysine (120 g/d) and MetiPEARL (60 g/d) added to the diet.
- Infused Low (IL): control diet plus abomasal infusion of low levels of lysine HCl (25 g/d) and DL methionine (7.5 g/d).
- Infused High (IH): control diet plus abomasal infusion of high levels of lysine HCl (75 g/d) and DL methionine (15 g/d).

The cows were fed twice daily with allotments adjusted for approximately 5% orts. For cows receiving FL and FH treatments, USA Lysine and MetiPEARL were mixed into 100 g of grain mix and placed in front of the cows for 10 minutes. Any feed not consumed in that time was collected and placed into the rumen. Additional grain without USA Lysine and MetiPEARL was provided to cows receiving IL and IH treatments.

Cows on all treatments were continuously infused with either saline or saline containing the dissolved amino acids. Total daily infusion times were approximately 19.5 h/d.

Periods were seven days in length. During day seven of the adaptation period, jugular blood samples were collected at 0 and 4 h post feeding. During treatment periods, jugular catheters were placed in each cow on day six of each period. On day seven, blood samples were collected at 0, 2, 4, 6, 8, 10 and 12 h after feeding. These samples were then sent to the University of Missouri Agricultural Experiment Station Chemical Laboratories (University of Missouri, Columbia, MO) for free amino acid analysis.

Cows were milked twice daily and milk yield was recorded at each milking throughout the study. Milk samples were collected at both milkings on day seven of each period. They were analyzed for lactose, protein, fat, SCC and MUN by NIR. Samples of TMR and forages were collected three times per week and composited. Grain mix and hay were sampled once a week. These samples were used to correct the ration for dry matter fluctuation.

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Results

The bioavailability for each product was determined using the slope regression method, where the slope of the regression of plasma AA versus fed AA was divided by the slope of the regression of plasma AA versus infused AA and multiplied by 100. Among the five cows used in the study, one cow did not respond to the infusion or feeding treatments, and the data generated for this cow were considered an outlier and removed from the dataset used to determine average bioavailability. This is a common practice in other bioavailability studies with rumen-protected AA1. The data from the four remaining cows were used to calculate an average bioavailability of 42.5% for USA Lysine (Figure 1) and 30.5% for MetiPEARL (Figure 2) based on individual cow bioavailability data.

There were no treatment effects on milk and intake variables (Appendix C). This was expected as the control diet was formulated to be sufficient in MP lysine and MP methionine.

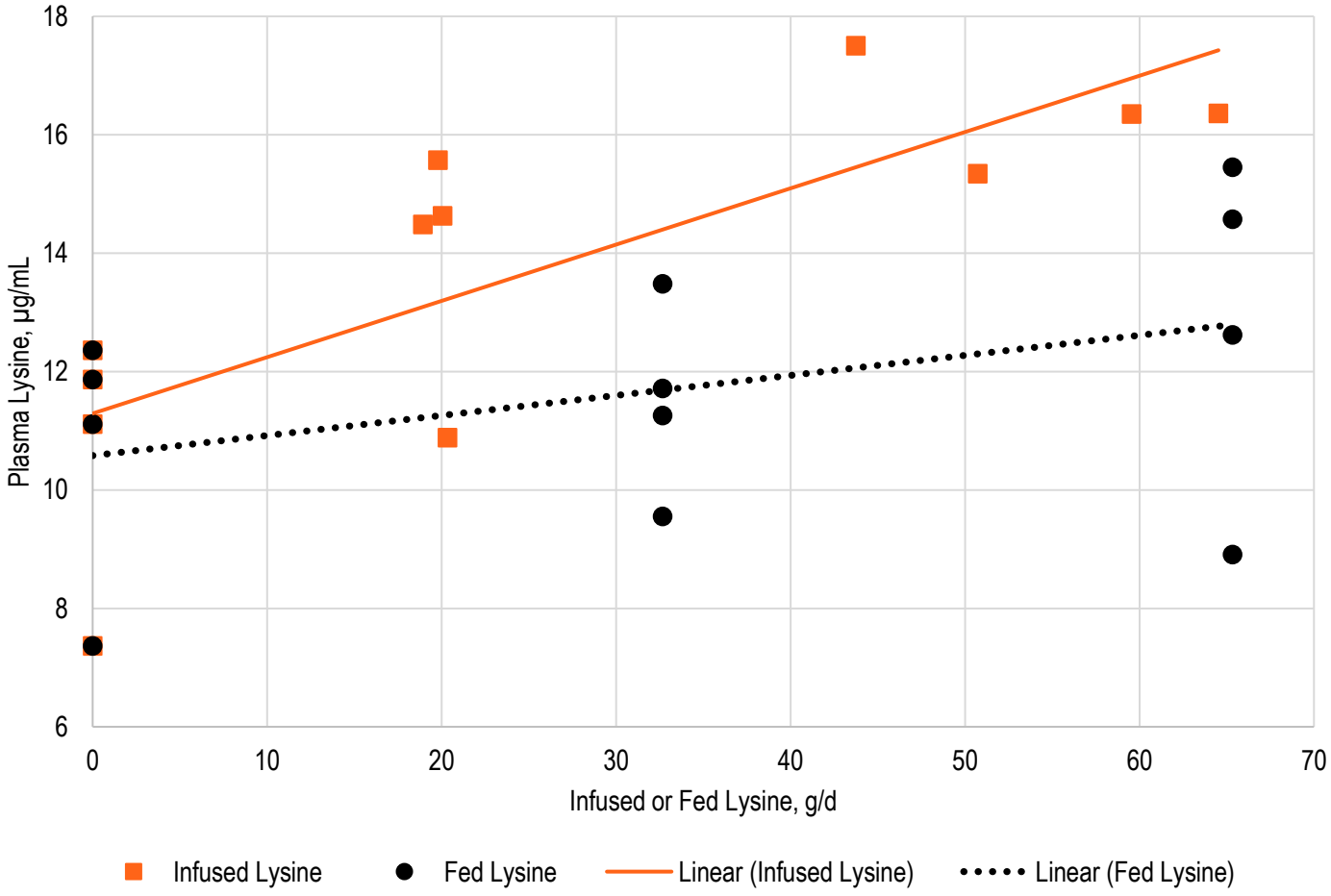

Figure 1. Single regression model on individual cow data to determine lysine bioavailability.

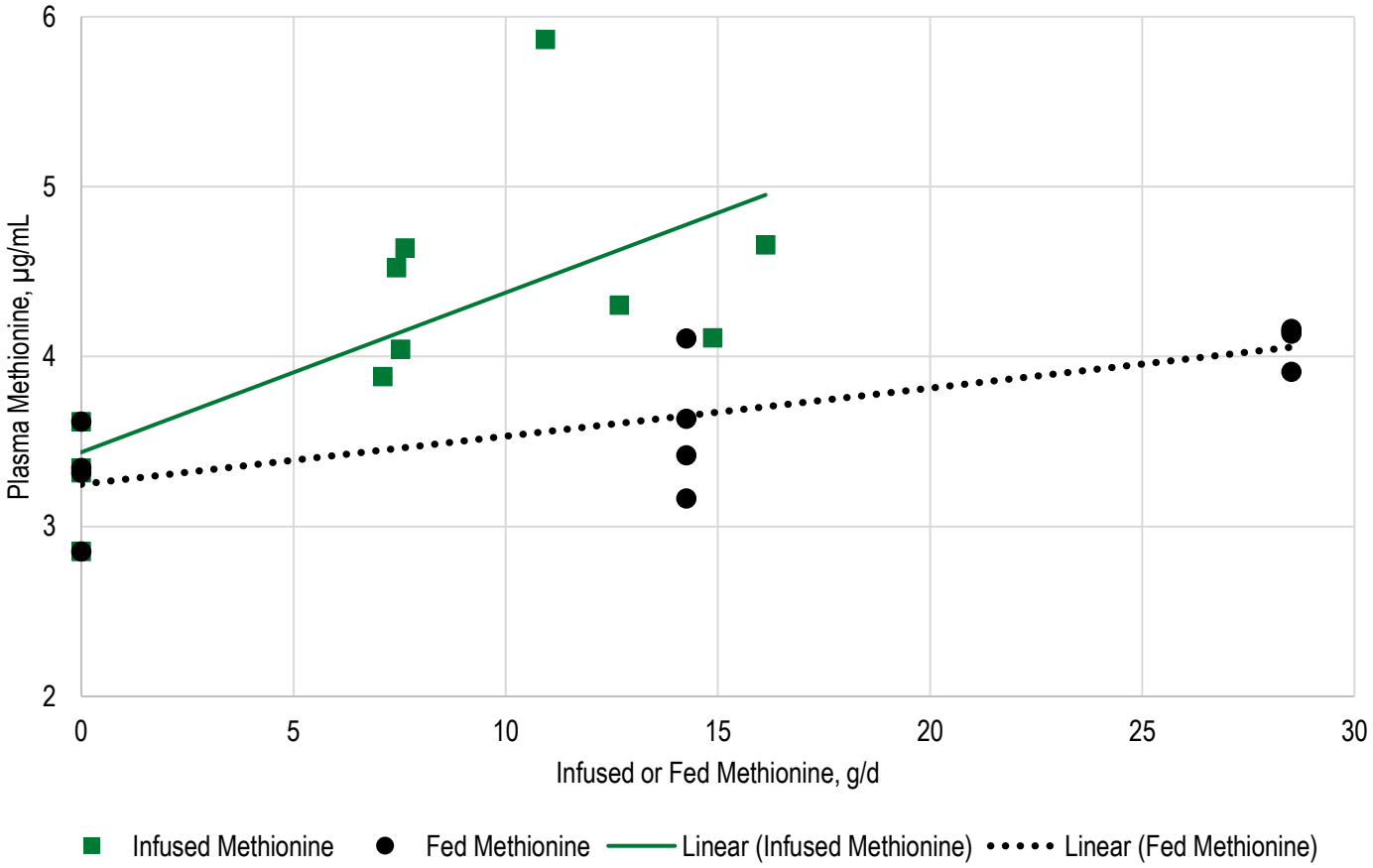

Figure 2. Single regression model on individual cow data to determine methionine bioavailability.

Discussion

This was the first study conducted to report the bioavailability of two different RPAA products simultaneously fed to the same cows. The 42.5% bioavailability value for USA Lysine in this study compares favorably to previous bioavailability studies, 43.5% determined by lysine levels in blood plasma[2] and 44% calculated in a modified three step in vitro model.[3] The 30.5% bioavailability value for MetiPEARL in this study was similar to previous results, 28.5% calculated in a modified three step in vitro model.[4]

Appendix A. Ingredient composition of base ration.[1]

Ingredient	% of ration dry matter
Corn silage	41.39
Alfalfa silage	11.28
Orchard grass hay	1.55
Canola meal	10.90
Ground corn grain	10.64
Corn distillers grain	8.65
Citrus pulp	6.48
Protected soybean meal[2]	2.87
Corn gluten meal	1.43
Sugar by-product[3]	0.80
Calcium carbonate	0.73
Sodium bicarbonate	0.62
Trace mineral and vitamin mix[4]	0.46
Rumen bypass fat[5]	0.46
Sodium chloride	0.44
Urea	0.44
Palm fat	0.35
Monensin[6]	0.31
Potassium carbonate[7]	0.12
Vitamin E[8]	0.040
Magnesium oxide	0.031
Biotin[9]	0.004
Live yeast[10]	0.002
Selenium[11]	0.002

[1]Diets were formulated using CPM software (University of Pennsylvania, Kennett Square, PA) with ratios for metabolizable Lys and Met from Cornell Net Carbohydrate & Protein System software (Cornell University, Ithaca, NY).
[2]Extruded and expelled soybean meal (J. L. Moyer & Sons, Inc., Turbotville, PA).
[3]Contained 92.3% sucrose.
[4]Contained 14.5% calcium, 32.4% magnesium, 0.9% sulfur, 1,750 mg/kg Fe, 5,704 mg/kg Zn, 1,074 mg/kg Cu, 2,904 mg/kg Mn, 65.4 mg/kg Se, 141.1 mg/kg Co, 190.6 mg/kg I, 1,332 KIU/kg Vitamin A, 266 KIU/kg Vitamin D, and 5,317 IU/kg Vitamin E.
[5]MEGALAC® (Church & Dwight Co., Inc, Princeton, NJ).
[6]Rumensin® 90, 4,400 g/ton (Elanco, Greenfield, IN).
[7]DCAD Plus™ (Church & Dwight Co., Inc, Princeton, NJ).
[8]Vitamin E, 44,100 IU/kg.
[9]Microvit® H Promit Biotin 2% (Addiseo, Antony, France).
[10]Levucell® SC (Lallemand Animal Nutrition, Milwaukee, WI).
[11]Contained 600 mg/kg Se and 7.5 IU/kg Vitamin E.

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Appendix B. Analyzed nutrient composition, expressed as mean (SD), of forages, grain mix and base ration TMR, along with formulated and calculated nutrient composition of base ration TMR.

		Forages				Total Mixed Ration (TMR)		
Nutrient	Unit	Corn silage	Alfalfa silage	Hay	Grain	Analyzed	Calculated	Formulated
DM	% as fed	39.2 (1.8)	40.5 (3.8)	87.1 (0.9)	88.2 (0.2)	53.5 (1.4)	62.6	
CP	% DM	7.9 (0.7)	19.4 (0.2)	13.2 (0.8)	26.5 (0.7)	16.3 (0.2)	17.8	18.1
ADF	% DM	22.6 (1.5)	38.8 (0.7)	36.7 (1.2)	13.4 (1.6)	21.8 (0.8)	20.4	20.3
aNDF	% DM	37.4 (2.5)	43.0 (1.3)	60.0 (2.9)	20.8 (1.9)	33.1 (0.8)	30.8	31.9
Starch	% DM	32.1 (1.3)	---	---	18.3 (1.9)	21.4 (0.5)	21.7	23.0
Ash	% DM	3.96 (0.18)	10.33 (0.14)	7.44 (0.78)	9.8 (0.65)	7.45 (0.62)	7.40	6.5
Ca	% DM	---	---	---	---	0.96 (0.10)	---	---
P	% DM	---	---	---	---	0.49 (0.03)	---	---
Mg	% DM	---	---	---	---	0.48 (0.03)	---	---
K	% DM	---	---	---	---	1.34 (0.10)	---	---
Na	% DM	---	---	---	---	0.53 (0.03)	---	---
Fe	mg/kg	---	---	---	---	340 (35)	---	---
Mn	mg/kg	---	---	---	---	61 (3)	---	---
Zn	mg/kg	---	---	---	---	59 (7)	---	---
Cu	mg/kg	---	---	---	---	12 (3)	---	---
TDN	% DM	---	---	---	---	72.1 (0.4)	---	---
NE_L	mcal/kg	---	---	---	---	1.67 (0.02)	---	---

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Appendix C. Effects of treatment on intake and production measures.

	Treatment[1]						
Parameter	**Control**	**FL**	**FH**	**IL**	**IH**	**SED**	***P*-value**
DMI, kg/d	28.79	27.11	27.89	28.37	28.13	0.89	0.45
Milk, kg/d	39.49	39.15	39.30	37.88	38.55	0.67	0.17
Fat, %	3.83	3.63	3.69	3.82	3.63	0.16	0.56
Fat, kg/d	1.51	1.43	1.45	1.44	1.41	0.06	0.52
Protein, %	3.03	3.04	3.05	3.11	3.12	0.05	0.27
Protein, kg/d	1.19	1.19	1.20	1.18	1.21	0.02	0.69
MUN	14.54	15.31	15.74	13.86	14.85	0.85	0.28
Lactose, %	4.76	4.78	4.80	4.73	4.75	0.04	0.55

[1]Treatments were: Control (diet sufficient in Lys and Met); Fed low (FL, control diet plus 60 g/d of USA Lysine & 30 g/d of MetiPEARL); Fed high (FH, control diet plus 120 g/d of USA Lysine & 60 g/d of MetiPEARL); Infused low (IL, control diet plus abomasal infusion of 25 g/d of lysine HCl & 7.5 g/d of DL Met); Infused high (IH, control diet plus abomasal infusion of 75 g/d of lysine HCl & 15 g/d of DL Met).

References

1. N. Whitehouse, A. Brito, C. Schwab, I. Shinzato, M. Miura. 2017. Bioavailability of AjiPRO-L 2G and AjiPRO-L 3G using the plasma free lysine dose-response technique. American Dairy Science Association 2017 Annual Meeting. (Abstract #M257).
2. Kemin Internal Document, 15-00077.
3. Kemin Internal Document, 15-00008.
4. Kemin Internal Document, 15-00010.
5. Kemin Internal Document, 17-00649.