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Short communication: Effect of on-farm feeding practices on rumen protected lysine products

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ABSTRACT

Two independent studies were conducted to determine whether mechanical mixing of total mixed ration (TMR) or TMR dry matter alters Lys release from 6 rumen-protected Lys (RPL) products (A, B, C, D, E, and F). In the first study, routine mixing procedures were simulated to determine if inclusion of RPL products in TMR altered in situ release of Lys. Following mixing, Dacron bags containing RPL products were ruminally incubated for 0, 6, 12, or 24 h to determine Lys release. The second study occurred independently of the first, in which Lys release from RPL products was evaluated when incorporated into a TMR that differed in dry matter (DM) content. Bags containing TMR and RPL product mixture were stored at room temperature for 0, 6, 18, and 24 h to simulate RPL product exposure to TMR when mixed and delivered once per day. Concentration of free Lys in both studies was determined using ultra-performance liquid chromatography. Following mechanical mixing, ruminal Lys release was significantly greater for C and tended to increase for F. Mechanical mixing did not alter ruminal Lys release from other RPL products evaluated. Hours of ruminal incubation significantly altered Lys release for all products evaluated, and a significant interaction of mechanical mixing and hours of ruminal incubation was observed for A and C. Exposure to lower TMR DM (40.5 versus 51.8%) significantly increased Lys release from B but did not alter Lys release from the other RPL products evaluated. Moreover, time of exposure to TMR significantly increased Lys release from all RPL products evaluated, and a significant interaction of TMR DM and time of exposure to TMR was observed for B and E. These data suggest mechanical mixing and variation in TMR DM may compromise the rumen protection of RPL products; therefore, on-farm feeding practices may alter efficacy of RPL products in dairy rations.

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Short Communication

Lysine is recognized as one of the first-limiting AA for lactating dairy cows fed a typical corn-grain based diet in North America (NRC, 2001). Due to microbial utilization and limited Lys content of feed protein, successful Lys supplementation systems require efficient postruminal Lys release and effective protection from rumen degradation (Berthiaume et al., 2000). Commercially available rumen-protected Lys (**RPL**) products use encapsulation, matrix technology, or a combination of both to protect a Lys core from ruminal degradation, often involving a series of lipid- or fatty acid calcium salt-based rumen protection techniques (Ardaillon et al., 1989; Wu et al., 1989; Ardaillon and Franzoni, 1992; Cummings et al., 1993).

Protection technology and subsequent extent of protection from ruminal degradation varies between commercially available products (Rogers et al., 1987; Wu et al., 2012). In the rumen environment, coating protection efficiency is dependent on coat composition, smoothness of pellet surface, hardness of the inner core pellet, solubility of active ingredient, and pellet size (Wu and Papas, 1997). Differences in coating protection and its efficacy can affect resistance to surface damage and Lys release especially due to physical contact with TMR ingredients (Wu and Papas, 1997). Little research has focused on farm feeding practices and their potential to alter the efficacy of coating protection of commercially available RPL products. Therefore, the objectives of this study were to determine potential Lys release from RPL products induced by on-farm feeding conditions related to mixing of TMR and changes in TMR DM.

Six commercial RPL products (**A**: AjiPro-L, Ajinomoto Heartland Inc., Chicago, IL; **B**: AminoShure-L, Balchem Corporation, New Hampton, NY; **C**: LysiPEARL, Kemin Industries Inc., Des Moines, IA; **D**: Megamine-L, Church & Dwight Co. Inc., Princeton, NJ; **E**: MetaboLys, H. J. Baker & Bro. Inc., Westport, CT; **F**: USA Lysine, Land O'Lakes Inc., Arden Hills, MN) were

used in 2 independent studies with completely randomized designs and split-plot arrangement of treatments to assess Lys release from each RPL product exposed to simulated on-farm feeding conditions. These studies were conducted at the William H. Miner Agricultural Research Institute (Chazy, NY), and the standard operating procedure for in situ digestion using cannulated cattle was approved by the William H. Miner Agricultural Research Institute Animal Care and Use Committee. Manufacturing companies were contacted before the start of both experiments and allowed to review and comment on the methodology. All products were sourced from the manufacturing company 1 mo before the start of the study, January 18, 2012. To characterize RPL products, free L-Lys was measured (UPLC System, Waters Corporation, Milford, MA), specific gravity was determined (AccuPyc 1330 Pycnometer, Micromeritics Instrument Corporation, Norcross, GA), particle size distribution was measured (Ro-Tap RX-29 sieve shaker; Laval Lab Inc., Laval, Quebec, Canada), and manufacturing details were summarized (Table 1).

To assess the effect of mechanical mixing of TMR on Lys release from RPL products, a Super Data Ranger (American Calan Inc., Northwood, NH) using paddle mixing was used to simulate the mechanical mixing force of a commercial farm TMR mixer. Each RPL product was weighed (1.00 ± 0.03 g) and heat-sealed into Dacron bags (5 cm × 10 cm, RPL product retention in bag, Table 1; Ankom Technology, Macedon, NY) to allow for recovery of RPL product posttreatment. Triplicates of Dacron bags were prepared for each combination of RPL product, mixing treatment, load, and incubation time. Blanks, in triplicate, were also included at each combination of mixing treatment, load, and incubation time. Dacron bags were either placed in a Super Data Ranger (American Calan Inc.) containing 350 kg of TMR (Table 2) and mixed at full speed (6.5 rotations per minute) for 6 min (MIX) or placed into a barrel, gently incorporated with TMR, and allowed to sit for 6 min (CON). This procedure was repeated to allow for replicate loads (n = 3). Dacron bags from both treatments were removed from the surrounding TMR and randomly allotted to ruminal incubation times (0, 6, 12, and 24 h). Dacron bags were then placed in a weighted mesh bag, and submerged in the ventral ruminal sac of one of 3 multiparous rumen-cannulated Holstein cows (DIM = 202 ± 8 d; 34.5 ± 0.9 kg/d milk) housed in a free-stall pen and fed the same corn silage-based diet once daily at 0600 h. Bags were incubated in reverse order (i.e., 24 h bags were inserted first) and removed simultaneously following incubation, gently washed in cold water by hand, and allowed to air-dry at room temperature (>24 h). Bags at 0 h were not placed in the rumen but were exposed to the same handling and washing procedures as those bags undergoing rumen incubation. Once dry, RPL residues including those from 0-h bags were acid hydrolyzed (AOAC method 954.02; AOAC

Table 1. Characterization of rumen-protected Lys products

Treatment	Rumen-protected Lys product					
	A	B	C	D	E	F
Commercial name	AjiPro-L[1]	AminoShure-L[2]	LysiPEARL	Megamine-L	MetaboLys	USA Lysine
Product lot number	AP20110722	452LEY11	E100618001	EE1286	01092P01	E100817002
Manufacture date	07/2011	12/2011	06/2010	10/2011	—	08/2010
Lys compound	L-Lys-HCl	L-Lys-HCl	L-Lys-HCl	L-Lys-HCl	L-Lys-H_2SO_4	L-Lys-HCl
Lys,[3] %	40.4	53.6	38.2	19.4	28.5	53.6
Specific gravity[4]	1.121	1.124	1.112	1.089	1.075	1.116
Particle size,[5] % of total weight						
>4.75 mm	5.2	0.0	0.0	84.7	0.0	0.0
3.35–4.75 mm	93.5	1.0	0.0	15.0	0.0	0.0
2.36–3.35 mm	1.3	62.1	0.0	0.3	0.0	0.0
1.18–2.36 mm	0.0	35.7	26.1	0.0	73.4	9.8
0.6–1.18 mm	0.0	1.2	46.7	0.0	26.2	63.1
0.3–0.6 mm	0.0	0.0	23.8	0.0	0.4	25.5
<0.3 mm	0.0	0.0	3.4	0.0	0.0	1.6
Strainer bag retention,[6] %	99.8	100.0	95.4	97.6	99.6	95.8
Dacron bag retention,[7] %	99.8	100.0	99.7	99.7	100.0	99.8

[1]Product A evaluated in this study is a first-generation product.

[2]Product B evaluated in this study is a second-generation product that is now commercially unavailable.

[3]Measured value using UPLC.

[4]n = 10.

[5]Particle size distributions were determined through Ro-Tap series sieve shaker for 3 min.

[6]Percent of RPL product retained in strainer bag after shaking bag containing 5 g of RPL product for 1 min.

[7]Percent of RPL product retained in Dacron bag after shaking bag containing 5 g of RPL product for 0.5 min.