Peer-reviewed paper: Joint South African Society for Animal Science/Grassland Society of Southern Africa Congress

The effect of a liquid rumen protected lysine on the productivity of Holstein cows

L.J. Erasmus[#], R. Venter[1] and R.J Coertze
Department of Animal and Wildlife Sciences, University of Pretoria, Pretoria 0002, South Africa

---

Abstract
Thirty Holstein cows in early lactation were used in a randomised complete block design to compare a lysine deficient diet, which was sufficient in methionine, to the same diet supplemented with a rumen protected lysine product. The lysine supplementation resulted in an optimal dietary lysine : methionine ratio in metabolisable protein of 7.2:2.4. Lysine supplementation did not affect dry matter intake, milk production, milk fat %, milk protein %, milk urea nitrogen, body weight or body condition score but decreased the non casein nitrogen and whey content of milk. Furthermore, milk casein, which is the milk nitrogen fraction most sensitive towards increased duodenal supply of lysine and methionine, was not affected. The rumen protected lysine product evaluated did not improve cow productivity, probably because the product was not protected sufficiently.

Keywords: Rumen protected lysine, Holstein cows, milk production and composition, milk casein
[#] Corresponding author. E-mail: lourens.erasmus@up.ac.za
[1] Present address: AFGRI, 33 Sloane Street, Knightsbridge Manor B2, Bryanston 2021, South Africa

Introduction
Amino acid nutrition of dairy cows has received much attention over the last decade resulting in several nutritional models, which allows for diet formulation on the basis of amino acids (AA). Based on the results of Rulquin *et al.* (1993), Schwab (1996) and others, it was concluded that optimal use of metabolisable protein (MP) for the combined functions of maintenance and milk protein production, requires concentrations of lysine and methionine in MP that approximate 7.2 and 2.4 percent, respectively (NRC, 2001). However, optimal concentrations of AA for milk protein synthesis are not readily achieved when using only conventional feedstuffs. The most practical way to reach these ratios of AA is dietary supplementation with rumen protected AA.

A considerable effort has been made to develop technologies for supplying lysine and methionine in forms that would allow them to escape ruminal degradation without compromising substantially their digestibility in the small intestine. The physical and chemical properties of lysine are such that most technologies are currently limited to methionine. The approaches to protect free amino acids from ruminal degradation fall into one of three technological categories: 1) surface coating with a fatty acid/pH sensitive polymer mixture, 2) surface coating or matrices involving fat or fatty acids and minerals, and 3) liquid sources of methionine hydroxy analogue (NRC, 2001). Recently, a new rumen protected lysine product, with rumen protection obtained by a chemical process, was developed. This process is currently being patented and apart from this study no other lactation studies have been conducted.

The purpose of this study was to evaluate the response of lactating dairy cows when a lysine deficient diet was supplemented with rumen protected lysine.

Materials and Methods
Thirty Holstein cows in early lactation were used in a randomised complete block design to compare a lysine deficient diet to the same diet supplemented with rumen protected lysine. In both treatments the diet was sufficient in methionine. All cows received the lysine deficient diet (LYS-) for the first three weeks postpartum and were then blocked according to the average production from days 19-21. Lactation number, body condition score and body weight were considered in the blocking procedure. The experimental diets were fed from day 22 to 120 days postpartum.

The experimental total mixed diets were based on lucerne hay (313 g/kg), maize meal (332 g/kg) *Eragrostis curvula* hay (78 g/kg), maize gluten feed (78 g/kg), maize gluten meal (39 g/kg), whole cottonseed (78 g/kg), molasses (51 g/kg), urea (3.9 g/kg), protected fat (12 g/kg), sodium bicarbonate (7.8

g/kg) and a salt trace mineral mix (4.9 g/kg). The diets were calculated to contain (/kg DM) 170 g CP, 11.0 MJ ME, 302 g NDF, 53 g fat and 434 g NFC. The LYS-diet was formulated for a Rulquin ratio of 2.4% (methionine) and 5.57% (lysine) in MP using the CPM Dairy, version 2.0.25 (CPM–Dairy, 2002). Smartamine M, a commercially available rumen protected methionine, covered with a pH sensitive coating (Adisseo, Alpharetta, GA, USA) was supplemented to obtain the desirable dietary methionine level. The LYS-diet was then supplemented with rumen protected lysine to bring the Rulquin ratio to 7.2% (lysine) and named the LYS+ diet.

Seven hundred and fifty mL of the rumen protected lysine contained a calculated amount of 69 g of available lysine, which was the amount necessary to reach the optimal lysine to methionine ratio. The supplemental lysine was dissolved in 3 L water and thoroughly mixed into the ration each day. Water only was added to the rations of cows not receiving the rumen protected lysine.

Cows were fed for *ad libitum* consumption using Calan gates and were milked three times/day in a 10 point herringbone system equipped with a DeLaval Alpro milking system. Milk production and feed intake were measured daily, milk samples from the afternoon milking were taken weekly and analysed for fat, protein, lactose and milk urea nitrogen (MUN) (System 4000 Infrared Analyzer). After the midday milking cows were scored every 14 days for body condition (score 1 to 5) and body weight was measured using an electronic scale. Additionally milk samples were taken on day 50 and analysed for milk N fractions (casein, whey). Samples of the experimental diets were collected weekly and composited by treatment. Feed samples were analysed for OM, CP, EE, Ca and P (AOAC, 1990), NDF and ADF (Van Soest *et al.*, 1990) while NFC levels were calculated (Hall, 1998). Samples of orts were taken weekly and pooled within cow. Selected samples were analysed for CP and NDF to determine whether selection of feed ingredients had occurred.

An analysis of variance with the ANOVA model (SAS, 1994) was used to analyze the data as a randomized block design to determine the significance between different treatments and blocks. Means and standard error of the means (s.e.m.) were calculated. Significance of difference (5%) between means was determined by using the t-test (Samuels, 1989).

Results and Discussion

The effect of a commercial rumen protected lysine additive on the production parameters of lactating Holstein cows is presented in Table 1. The only effect was on the milk N fractions where rumen protected lysine decreased milk whey and non casein N percentages (P = 0.02). This can benefit the secondary dairy industry where milk with lower non casein nitrogen concentrations is preferred when making cheese. Dry matter intake was within the accepted norms for cows producing 40 kg of milk/day (NRC, 2001). Milk composition, MUN and condition score were within the expected range for cows in early lactation. Milk casein %, which is important for cheese yield, did not differ (P = 0.15) between treatments.

Table 1 Effect of rumen protected lysine on dry matter intake, milk production and composition, body weight and body condition score of Holstein cows from day 22 to 120 postpartum (n = 15 cows/treatment)

	LYS -	LYS +	P =	s.e.m.
DMI (kg/d)	25.4	25.8	0.75	3.09
Milk (kg/d)	40.0	40.2	0.83	2.24
Fat (%)	4.27	4.32	0.59	0.26
Protein (%)	2.97	2.98	0.85	0.10
Casein (%)	2.07	2.18	0.15	0.15
Whey (%)	0.63[a]	0.54[b]	0.02	0.02
Non casein N (%)	0.80[a]	0.71[b]	0.02	0.02
MUN (mg%)	13.8	14.2	0.60	2.62
Body condition score	2.8	2.8	1.00	0.26
Body weight (kg)	602	595	0.72	56.5

[ab] Means in the same row with different superscripts differ (P < 0.05), MUN = milk urea nitrogen
LYS- = Lysine deficient diet: LYS+ = diet supplemented with rumen protected lysine; s.e.m. = standard error of the mean

The nature of production responses of lactating cows where amino acids were either infused or supplemented in rumen protected form, to increase postruminal supplies of lysine and methionine, has been reviewed (NRC, 2001) and indicates the following: 1) content of milk protein is more responsive than milk yield to supplemental lysine and methionine, particularly in post-peak lactation cows, 2) casein is the most influenced milk protein fraction, 3) milk yield responses are more common in early lactation, 4) increases in milk protein percentage are independent of milk yield, and 5) production responses are more common when CP in diet approximates 14 – 18% CP. Furthermore, increases in milk protein production to increased supplies of either lysine or methionine are the most predictable when the predicted supply of other AA in MP is near or at estimated requirements (Schwab, 1996). Garthwaite *et al*. (1998) summarized 11 experiments in which ruminally protected forms of methionine or lysine or both were supplemented. When supplementation commenced 0 to 35 days after calving, the cows responded with an average of +0.7 kg milk, +0.16 percentage units milk protein, and +79 g milk protein.

None of the above-mentioned most sensitive parameters (casein %, milk protein %, milk protein yield) were affected by rumen protected lysine supplementation, suggesting that there were either no need for additional lysine or that the rumen protected supplement was not effective. Although the authors would have preferred the LYS- diet to be more deficient in lysine, they found it difficult to formulate a diet that is sufficient in methionine and very limiting in lysine, while still remaining a diet that could be utilized in practice. The diet was thus formulated to meet requirements for methionine, while being deficient in lysine and supplying only 93% of requirements. Results, therefore, suggest that although there was theoretically a need for additional lysine, the supplemented lysine was probably not utilized either because of high degradability in the rumen or perhaps low availability (over protection) in the small intestine.

Conclusion

The liquid rumen protected lysine product evaluated did not affect any of the economically important parameters measured, suggesting that the product is either rumen degradable or the lysine is not available for digestion and absorption in the small intestine.

References

AOAC, 1990. Association of Official Chemists, Official Methods of Analysis. 15th Ed., Vol. 1. Arlington, VA, USA.

CPM-Dairy, 2002. Software that brings a new approach to dairy nutrition. University of Pennsylvania. http://www.vet.upenn.edu/comm./publications/bellwether/41/cpm-dairy.html.

Garthwaite, B.D., Schwab, C.G. & Sloan, B.K., 1998. Amino acid nutrition of the early lactation dairy cow. Proc. Cornell Nutr. Conf. Feed Manuf., Rochester, NY, USA. pp. 38–50.

Hall, M.B., 1998. Making nutritional sense of nonstructural carbohydrates. Proc. Florida Rumin. Nutr. Symp. Gainesville, FL, USA. pp. 108–122.

NRC, 2001. National Research Council. Nutrient Requirements of Dairy Cattle. 6th Ed. Nat. Acad. Sci., Washington D.C., USA.

Rulquin, H., Pisulewski, P.M., Verite, R. & Guinard, J., 1993. Milk production and composition as a function of postruminal lysine and methionine supply: a nutrient response approach. Livest. Prod. Sci. 37, 69 – 90.

Samuels, M.L., 1989. Statistics for the Life Sciences. Collier MacMillan Publishers, London.

Schwab, C.G., 1996. Rumen protected amino acids for dairy cattle: Progress towards determining lysine and methionine requirements. Anim. Feed Sci. Technol. 59, 87–101.

SAS, 1994. Statistical Analysis Systems user's guide. Statistics version 6. SAS Institute Inc., Cary, NC, USA.

Van Soest, P.J., Robertson, P.J. & Lewis, B.A., 1990. Methods for dietary fiber, neutral detergent fiber and non starch polysaccharides in relation to animal nutrition. J. Dairy Sci. 74, 3583–3597.