INFLUENCE OF DIETARY NITROGEN CONTENT AND INCLUSION OF RUMEN-PROTECTED METHIONINE AND LYSINE ON NITROGEN UTILIZATION IN THE EARLY LACTATION DAIRY COW

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Introduction

Attention has been drawn recently to the importance of the balance of amino acids absorbed at the level of the small intestine for the high producing dairy cow. Methionine and lysine have been shown to be limiting for milk protein synthesis in certain feeding regimes (Robers et al., 1987; Rulquin, 1987; Schwab et al., 1988). In this trial we wished to investigate the role of duodenal amino acid balance on the efficiency of utilization of dietary N for milk protein synthesis.

Materials and Methods

Four, multiparous, double cannulated (rumen and proximal duodenum) Friesian/Holstein dairy cows (5-8 weeks into lactation) were assigned to a 4x4 Latin square (2 week periods). Treatments imposed were two levels of dietary crude protein (CP) [151 vs 168 g/kg dry matter (DM)] and two levels of rumen protected amino acids (RPAA) (0 vs 8 g methionine, 24 g lysine; quantities calculated to be available post-ruminally). The basal ration (151 g CP/kg DM) was maize silage *ad libitum*, 1 kg hay, 1.52 kg soyabean meal and 5.2 kg concentrate (wheat: 180, unmolassed beet pulp: 205, coarse wheat bran: 180, soyabean meal: 257, pelleted alfalfa: 77, fat: 41, calcium carbonate: 15, salt: 4, g/kg fresh weight).

The 168 g CP/kg DM diet was achieved by substituting 1 kg soyabean meal for 1 kg concentrate. The silage allowance was split into 8 meals/day and distributed automatically at three hour intervals.

The other ration constituents were offered in 4 equal meals (08:00, 11:00, 14:00, 17:00), the protected amino acids being mixed with the soyabean meal immediately before feeding. During the measurement phase (second week of each period) the cows were fitted with a harness to facilitate the collection of faeces (5 day total collection). For each cow, the DM (oven DM – 12 hours at 104°C) and N (Kjeldahl) contents of the ration constituents and refusals were determined. Likewise faecal DM (72 hours at 80°C) and N content was determined. Two blood samples were taken at 10:30 on the 3rd day of the measurement period. For one the plasma was separated and deproteinised with sulfosalicylic acid and subsequently analysed for the concentration of individual amino acids on a Beckman amino acid analyser. For the other, the plasma was collected and analysed for urea content. Milk was weighed at each milking (06:15, 17:45). Milk true protein concentration (infra-red) was determined on milk samples from six consecutive milkings. Milk casein and milk urea concentrations were determined on the last sample of each sequence. The former was measured as the difference between milk total N and the filtrate N obtained after precipitation of milk in an acetate buffer.

Results and Discussion

As previewed, both increasing N concentration in the ration and adding RPAA increased N intake. The increases in plasma methionine and lysine concentration to RPAA supplementation indicated these amino acids were successfully rumen protected and released in the small intestine. N excretion was not influenced by ration CP level or RPAA addition due to N disappearance being greater at the higher level of each factor although an interaction was noted for N disappearance. Increasing ration N concentration tended to increase milk yield ($P < 0.06$) whereas addition of RPAA increased milk protein concentration such that both factors increased milk true protein yield (= +40 g) non significantly ($P < 0.1$). Milk casein concentration was improved by RPAA addition with no effect on milk urea concentration.

Expressing N utilization as [milk N (true pro-

TABLE 1. MILK PERFORMANCE, N UTILIZATION AND PLASMA AMINO ACID CONCENTRATIONS

Ration CP content Amino acid supply	151 g/kg DM 0	 +	168 g/kg DM 0	 +	SED	Sig.
DM Intake (kg/day)	16.9	17.1	16.8	17.0	0.25	
Milk (kg/day)	25.9	26.3	26.9	26.9	0.34	
Milk protein (g/kg)	26.8	28.3	27.8	29.1	0.48	a
Protein yield (g/day)	694	741	745	780	19.9	
Casein (g/kg)	21.3	22.8	22.2	22.8	0.41	a
Urea (mg/kg milk)	527	547	535	555	20	
N intake (I) (g/day)	401	428	450	465	3.7	NA
Faecal N (F) (g/day)	105	101	100	109	4.60	
N disappear (I-F) (g/day)	297	327	349	355	3.90	NAi
Milk N/(I-F)	0.37	0.36	0.34	0.35	0.01	
Plasma amino acids (mg/100 g)						
Methionine (M)	0.17	0.33	0.18	0.35	0.03	A
Lysine (L)	0.70	0.96	0.69	1.22	0.09	A
Citrulline (C)	1.10	0.91	1.17	1.31	0.08	n
Ornithine (O)	0.38	0.41	0.42	0.53	0.04	
Arginine (A)	0.83	0.79	0.73	1.03	0.04	aI
C+O+A (urea cycle)	2.31	2.11	2.32	2.87	0.09	NI
NEAA	6.28	5.72	6.38	6.79	0.16	Ni
EAA minus (M + L)	6.93	6.37	7.35	7.95	0.42	
Urea (mg/l)	260	263	328	350	30	N

N (n)-ration N level effect, A (a)-amino acid effect, I (i)-interaction effect, NAI-$P < 0.01$, nai-$P < 0.05$.

tein)/(N ingested − N faeces)] revealed increasing ration N concentration tended to decrease N utilization ($P < 0.1$) but addition of RPAA did not change N utilization. The increase in blood urea concentration and the increased concentrations of amino acids associated with the urea cycle (arginine, citrulline, ornithine) further confirmed the more inefficient utilization of dietary N as ration N concentration increased. Milk performance responses to RPAA appeared to be independent of ration N level.

However various plasma amino acids (arginine, total non essential (NEAA), urea cycle) interaction effects, were noted. Thus, the performance responses to RPAA were perhaps the consequence of N transformations at the digestive and/or metabolic level which were not independent of ration N level. The effects of ration N concentration and addition of RPAA on both rumen N degradability and efficiency of N capture for rumen microbial synthesis will determine the importance of ammonia loss across the rumen wall relative to amino acids absorbed in the small intestine. This relation will influence the efficiency of utilization of N disappearing from the digestive tract for milk protein synthesis. Interpretation of this study will be aided by the determination of duodenal individual amino acid flows.

(**Key Words**: Dairy Cow, Rumen Protected Amino Acids, Nitrogen Utilization)

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