Effect of N underfeeding and energy source on milk production and N partition in dairy cows

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Introduction Improving dietary N utilization by dairy cows is a way to reduce N output in manure and is desirable due to global concerns about contribution of agricultural N to environmental pollution (Calsamiglia *et al.*, 2010). However, this strategy should not impair animal performance. It is hypothesised that the nature of digested energy may interact with protein digestion and metabolism. The objective of this study was to determine the consequences of a large decrease in N dietary supply in dairy cows and its interaction with the nature of energy, on milk production and N partition.

Material and methods Four Holstein cows weighing on average 662 ±62 kg and at 71 ±10 d of lactation at the beginning of the experiment, fitted with rumen, proximal duodenum and terminal ileum cannulae, were used in 4x4 Latin square design. Treatments were two N levels (low and high level) combined with two energy sources rich in starch (S) or fibre (F). On a dry matter (DM) basis, the four diets had the same forage proportion (0.405 maize silage, 0.10 natural grassland hay, first cut; 0.09 dehydrated lucerne). The high level of N (H) met 110% of N cow requirements expressed in the French protein digestible in the intestine (PDI) system (INRA, 1989) with an adequate supply in ruminal degradable N, whereas the low level (L) covered 80% of PDI requirements with a shortage in ruminal degradable N. In the H diet, the main N sources were soybean meal and urea. The four diets were iso-energetic and the difference between the two energy sources was based on the composition of energetic concentrate used. In the S diets, the starchy concentrate was made with mixture of a proportion of 0.39 of barley, 0.46 of wheat and 0.15 of maize. In the F diet, the fibrous concentrate was made with a mixture of soybean hulls and dehydrated beet pulp. The DM intake was the same among diets so that any effect of intake level on digestion was avoided. Diet was distributed twice daily at 0900 and 1700h. Each experimental period lasted 28d and consisted of 22d of adaptation to the diet and 6d of measurements. N partition was determined by total milk, faeces and urine collection. Milk N was calculated by dividing milk protein by 6.38. Statistical analysis was performed using GLM procedure of SAS with N level, energy source, interaction between N level and energy source, and animal as effects.

Results The DM intake was similar for both treatments (Table 1), as defined by the experimental design. Both milk production ($P < 0.01$) and urea content of the milk were higher ($P < 0.01$) with H than with L diets. Neither milk fat content nor milk protein content was affected by the N level of the diet. Milk protein was higher ($P < 0.05$) for S diets. There was no interaction between the N level and the energy source for any parameter. Daily output of N in urine and milk were 0.52 and 0.11 times lower with L diets than with H diets, respectively. When expressed as percentage of N intake, urinary N excretion was 1.6 times higher ($P < 0.01$) with H than with L diets, whereas the faecal N excretion and the milk N excretion was 0.18 and 0.14 times lower ($P < 0.05$ and $P < 0.01$, respectively) with H diets than with L diets.

Table 1 Performances and N balance in dairy cows receiving diets containing starch or fibre concentrates, at low or high N level

	L		H		SEM	Statistical
	S	F	S	F		analysis
Dry matter intake (kg/d)	20.0	20.3	19.9	20.4	0.39	ns
Milk yield (kg/d)	22.5	22.7	24.1	25.7	0.55	N**
Milk fat (g/kg)	36.0	37.8	35.1	38.6	2.72	ns
Milk protein (g/kg)	30.0	28.4	30.7	28.2	0.67	E*
Milk urea (g/kg)	0.113	0.166	0.222	0.266	0.0271	N**
N intake (g/d)	352.1	359.9	452.6	470.9	7.18	N**
Faecal N (g/d)	149.1	156.6	155.2	168.1	7.77	ns
Urinary N (g/d)	52.8	61.3	115.0	120.6	7.49	N**
Milk N (g/d)	105.3	100.8	116.6	113.6	3.88	N*

N: effect of N level; E: effect of energy source; ns: non significant; *: $P < 0.05$ - **: $P < 0.01$

Conclusions A strong reduction of dietary N significantly decreases both milk yield and N excretion in the environment. When dietary N decreases, the percentage of transfer of N into milk increases, and there is a strong decrease in urinary losses, in percentage of N intake as in daily output. In this study, only milk fat and protein were changed by the energy source, whatever the N level was.

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