Bypass Protein

2. Production responses in early and late lactation

In the early 1980s, new systems of dairy diet formulation were introduced by the Agricultural Research Council (ARC) in the UK and the National Research Council (NRC) in the US. Both systems are based on the concept that milk production may be limited by the amount of protein available for digestion in the small intestine. To reduce this limitation, these systems suggest feeding greater amounts of bypass protein as production potential increases. As discussed in the first article of this series (**1P1**), bypass protein refers to protein which is *undegradable* by rumen microbes as it passes through the rumen.

Although these two systems are based on similar concepts, the ARC system suggests substantially lower bypass protein requirements than the NRC system. We have conducted several trials to determine which of the two might be more applicable to the feeding of lactating cows in Alberta. Here are the results of two of those trials:

Late lactation cows

At the start of this trial, cows were between151 and 203 days in milk (DIM). For the first 28 days, all cows were fed the same ration, which was a compromise between ARC and NRC bypass protein recommendations (diet 3 below). In 3 subsequent 28-day periods, cows received one of 5 diets representing stepwise increases in bypass protein content ranging from a level which was as close as possible to ARC recommendations up to a level exceeding NRC recommendations.

Using typical Alberta feeds, it was not possible to formulate a diet as low in bypass protein as that recommended by ARC. Bypass protein levels were adjusted by replacing canola meal with increasing amounts of corn gluten meal. Every 28 days, energy levels were adjusted to reflect reduced requirements as lactation progressed.

Dry matter intakes and production responses (table 1) demonstrate no significant differences between cows on any of the 5 diets (see article **1F2** page 2 for an explanation of statistical significance). We interpret these results to suggest that the bypass protein intakes recommended by NRC for late lactation cows are substantially higher than actual requirements. The diet with the lowest level of bypass protein possible given the available feeds appeared adequate to support the production potential of these cows.

Early lactation cows

Our late lactation trial was followed by a similar trial using early lactation cows. This time, 3 diets were offered: the first, formulated to satisfy ARC recommendations, contained canola meal, fish meal and corn gluten meal. In the second, formulated to NRC recommendations, the canola meal was replaced by increased amounts of fish and corn gluten meals. The third was a 50:50 mix of the ARC and NRC diets. All cows were fed this third diet for 28 days immediately after calving before being randomly assigned to one of the 3 for a 7 week experimental period.

	Diet					Requirement	
	1	2	3	4	5	ARC	NRC
Intakes:							
Dry Matter, kg/day	18.3	18.5	18.7	18.9	18.7		
Crude Protein, g/day	2978	3022	3066	3111	3089	1726	2774
Degradable protein, g/day	2561	2470	2376	2279	2131	1620	1898
Undegradable protein, g/day	417	552	690	832	958	106	876
Production responses:							
Milk Yield, kg/day	19.6	19.5	19.6	19.7	20.2		
Milk Fat, %	4.01	3.94	4.02	4.19	4.07		
Milk Protein, %	3.44	3.41	3.46	3.43	3.43		

Table 1 : Intakes and production responses averaged over 3 periods of the late lactation trial.

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	Requirement	Intake
	----- grams/day -----	
Lactation 1 cows:		
Degradable protein		
ARC diet	1318	1914
NRC diet	1685	1598
Undegradable protein		
ARC diet	516	626
NRC diet	939	802
Lactations 2+ cows		
Degradable protein		
ARC diet	1781	2246
NRC diet	1910	1858
Undegradable protein		
ARC diet	748	734
NRC diet	1164	932

Table 2 : Protein intakes compared with requirements for cows on the early lactation trial.

As shown in table 2, protein intakes in this trial were, in some cases, lower than the requirements defined by either ARC or NRC. This was a direct result of dry matter intakes which were approximately 10% lower than predicted for all 3 diets. In spite of this, substantial differences in both degradable and undegradable protein intakes were achieved between the ARC and NRC diets.

	Diet		
	ARC	50:50	NRC
Intakes:			
Dry Matter, kg/day			
Lact 1 cows	16.6	18.2	15.7
Lact 2+ cows	19.5	18.4	18.5
Crude Protein, g/day			
Lact 1 cows	2.54	2.80	2.40
Lact 2+ cows	2.98	2.72	2.79
Production responses:			
Milk Yield, kg/day			
Lact 1 cows	24.8	25.3	24.5
Lact 2+ cows	30.0	31.6	33.8
Milk fat, %			
Lact 1 cows	3.18	4.00	3.43
Lact 2+ cows	3.24	3.12	3.16
Milk protein, %			
Lact 1 cows	3.02	3.16	3.00
Lact 2+ cows	2.96	2.91	2.86
Weight change, g/day	-192	-55	-64
Plasma urea, mg/dl	20.9	20.5	23.3

Table 3 : Average intakes and production responses for cows on the early lactation trial.

Comparing responses of cows on the 3 diets, we found no significant differences in either milk yields for first lactation cows, or milk composition for cows of either parity (table 3). However, cows in their second or later lactations produced significantly more milk on the 50:50 diet compared with the ARC. And those fed the NRC diet produced significantly more than those on the 50:50 diet. Figure 1 demonstrates markedly improved persistency of milk production for second and later lactation cows fed the NRC diet.

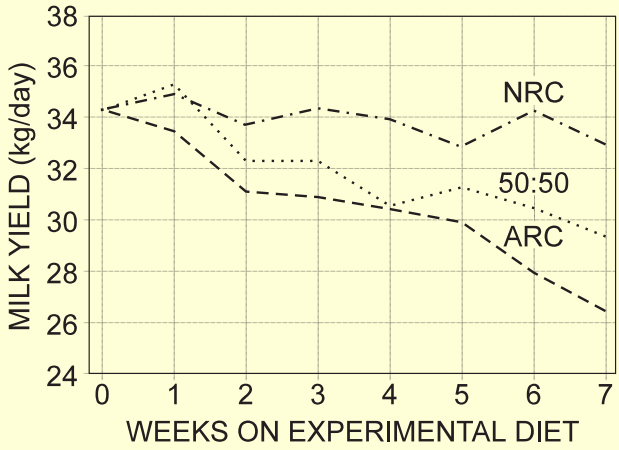

Figure 1 : Weekly production of cows from 4 to 11 weeks post-partum in their second or later lactations.

Table 3 also indicates that cows of all parities fed the ARC diet lost more body weight than cows on the other 2 diets, although these differences were not statistically significant. Cows consuming the NRC diet had significantly higher plasma urea levels despite their lower degradable (table 2) and crude protein (table 3) intakes. This observation is inconsistent with the idea that higher intakes of these two protein fractions inevitably raise blood and milk urea concentrations.

Summary

Results of our late lactation trial suggest that a diet formulated to the minimum practical level of bypass protein possible with our available feeds would support the requirements of cows producing 19-20 kg of milk. However, early lactation cows demonstrated marked improvement in milk yield, persistency and body weight retention when fed a diet formulated to deliver bypass protein intakes approaching those recommended by NRC.

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