EFFECT OF BYPASS PROTEIN OR BYPASS STARCH ON MILK YIELD AND BODYWEIGHT GAIN IN GRAZING DAIRY COWS

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SUMMARY

Grazing cows in midlactation were supplemented with bypass protein, bypass starch or soluble protein and starch. All supplements were isocaloric (25.7 MJ of ME), and bypass starch was isonitrogenous with soluble starch/protein.

There were no significant differences between treatments for milk yield or milk composition. Supplementation with bypass starch increased live weight gain (P <.08) compared to soluble starch/protein. The results suggest that the energy of starch escaping rumen fermentation may be directed towards liveweight gain rather than milk production.

INTRODUCTION

In recent years, there has been considerable interest in protecting dietary nutrients from rumen fermentation and thus ensuring greater amounts of nutrients for metabolism in the animal. In dairy cows, bypass protein has given mixed results. On low energy diets, Ørskov (1981) observed that bypass protein increased milk yield, but caused marked body weight loss presumably due to fat mobilization. On subtropical pastures, Stobbs et al. (1977) reported increases in both milk yield and live weight gain when cows were supplemented with bypass protein possibly due to increased pasture intake. Bypass starch has received less attention than protein, but its effect on ruminant production is far from understood. Due to physical and chemical structure, certain grains (maize, sorghum and rice) are slowly fermented, thus allowing some starch to move out of the rumen and be absorbed from the small intestine (Waldo 1973). In the studies now reported, the object was to determine the effects on milk yield and live weight gain of isocaloric bypass protein and bypass starch diets, and isonitrogenous bypass starch and soluble starch/protein diets.

MATERIALS AND METHODS

Thirty nine Holstein cows in early to mid-lactation (group means for days postpartum varied from 138-142 days at the beginning of the trial) were randomly allotted to one of three supplements. Bypass protein consisted of 70% pre-press solvent extracted cottonseed meal and 30% cracked polished rice. Bypass starch consisted of 74% cracked polished rice and 26% cottonseed meal. Soluble starch and protein consisted of a commercial pellet containing (g/100 g) 51 wheat, 33 barley, 8 wheat mill run, 2.3 cottonseed meal, 1.2 urea and 4.5 salt/minerals/vitamins. Cows were fed the supplements in two feedings (65% in A.M. and 35% in P.M.) during milking. Between milkings, cows were allowed to strip graze Japanese millet. Over the 60 days in which the experiment lasted, the millet passed from early to full inflorescence and was later regrazed. Pasture measurements indicated that animals consumed only 40-50% of the dry matter that was available to them in the strip. Milk yield and composition and body weight were measured every 10 days. Blood samples for insulin analysis were taken near the end of the trial on two consecutive days during the afternoon milking. Degradability of rice, cottonseed meal and commercial pellets (nylon bags in the rumen) were estimated in fistulated dairy goats fed a diet consisting of (g/100 g) 45 oat chaff, 15 fresh grass and 10 each of molasses, wheat, rice and cottonseed meal.

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RESULTS AND DISCUSSION

Hand plucked herbage (approximate consumed portion) over the 60 day period contained between 21-29% dry matter, 14-15% crude protein and 31-39% acid detergent fibre. The composition and rumen degradability of the supplements are shown in Table 1.

TABLE 1 Composition and rumen degradability of dietary components

	Supplement		
	Bypass protein	Bypass starch	Soluble starch/ protein
Total intake (kg)	2.41	2.33	2.40
Total M.E. (MJ)	25.7	25.7	25.7
Total crude protein (kg)	0.76	0.38	0.38
Nylon bag data*			
D.M. loss, 6 h	31.0[a]	13.8[b]	44.0[c]
D.M. loss, 12 h	34.5[a]	39.1[a]	62.7[b]
D.M. loss, 24 h	47.7[a]	73.4[b]	73.4[b]

a-c different superscripts differ (P < .05) between rows
*Nylon bag - separate ingredients; B.P. = cottonseed meal; B.S. = rice; SS/P = whole pellets

From the nylon bag data, it is evident that cottonseed meal was quite resistant to ruminal degradation after the initial loss (30%) of a soluble fraction. In contrast, a large proportion of the commercial pellets appeared to be rapidly degraded by 12 hr, and then slowly degraded afterwards. Rice was broken down at a fairly constant rate of 3% dry matter/hour.

The effect of supplements on milk yield, composition, live weight change and plasma insulin levels are shown in Table 2.

TABLE 2 Effect of treatments on production live weight and insulin

	Supplement		
	Bypass protein	Bypass starch	Soluble starch/ protein
Milk yield l/day	18.1	17.9	16.7
Milk fat %	3.9	4.0	3.9
Milk protein %	3.2	3.2	3.2
Solid nonfat %	8.5	8.5	8.6
60 day weight			
Live weight change (g/day)	+80[a,b]	+250[a]	-120[b]
Insulin (ng/ml)	0.36	0.45	0.38

a,b different superscripts differ (P < .08) between rows

Despite marked differences in rumen degradability and twice the crude protein content in the "bypass protein" supplement, there was only a slight (7-8%) increase in milk yield, with no difference in milk composition.

The only marked difference was for live weight change. Cows on bypass starch gained significantly more weight (P < .08) than cows on the soluble starch/protein supplement. Better weight gains were also recorded for the rice supplemented group compared to cows supplemented with cottonseed meal. It should be noted that cottonseed meal contains approximately 32% nitrogen free extract and 30% rapidly degradable dry matter (NAS 1969), amounts greater than in formaldehyde-casein which promoted liveweight gains in cows grazing subtropical pasture (Stobbs et al. 1977).

If pasture intake was assumed to be similar and energy output in milk was equal, where did the additional energy for live weight gain come from? Fermentation balance equations (Ørskov et al. 1968) predict that 20-30% of the energy of carbohydrates is lost as methane and heat of fermentation. Armstrong et al. (1957, 1960) observed an apparent difference in the efficiency of energy utilization favouring abomasal glucose over ruminal propionate infusions. From these laboratory observations, it is possible that the additional metabolizable energy made available through bypass starch escaping rumen fermentation supported the additional weight gained.

Stokes and Thomas (1977) reported that the efficiency of fattening increased linearly with the proportion of maize starch in the diet, suggesting a link between postruminal starch absorption (glucose uptake) and efficient fat deposition. This effect may be linked to hormone levels, particularly insulin. Increased insulin secretion will stimulate glucose uptake by body tissue and inhibit mobilization of both protein and fat reserves (Baird 1981). Although the large amount of within-animal (daily fluctuation) and between animal variation makes it difficult to assess hormone levels in the field, the 18-25% increase in plasma insulin (Table 2) on the bypass starch treatment may help to explain the increased weight gain.

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