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BRIEF COMMUNICATION: Energy rather than protein content of hind intake determines growth rate of red deer calves

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INTRODUCTION

Live weight gain of red deer within the first 3 to 4 months of their life plays a major part in determining the efficiency of venison production systems. Over this period young deer are largely dependant on their dam for nutrition. It is often difficult to achieve growth rates greater than 400 g/d in New Zealand because red deer lactation coincides with deteriorating pasture quality. However, calf growth rates of up to 700 g/day have been achieved over late lactation when novel crop and forage species were incorporated in the nutritional regimen (Beatson *et al.*, 2000). This probably represents the upper limit of red deer calf growth rate potential. It raises questions about the optimal nutrition requirements of lactating hinds, because even when they are offered good quality ryegrass/clover pastures, the true genetic potential for calf growth is rarely achieved. In summer, leafy ryegrass/white clover pasture has 10.3 MJ ME/kg DM and 15% CP as compared to chicory which has 12.5 MJ ME/kg DM and 25% CP. It may be that protein content of summer pasture limits hind milk production and calf growth rate because red deer milk has higher protein content (7 to 9%) than that of both sheep (5.5%) and cattle (3.4%) (Arman *et al.*, 1974; Jenness & Sloan, 1970). Also, Landete-Castillejos *et al.* (2001) found that protein content of red deer milk was the component most closely related to calf growth. The present study investigated the hypothesis that protein availability to the hind during lactation may be limiting calf growth potential.

MATERIALS AND METHODS

The study was a two by two factorial design with four replicates. The factors were energy and protein. Diet energy and CP densities are presented in Table 1. Eighteen multiparous red deer hinds were conditioned, at pasture, to a "standard" pellet ration from 3 November to 14 November before being individually housed indoors. Initially hinds were offered an *ad-libitum* ration of "standard" pellets and 5% by weight lucerne chaff for roughage. Residuals from the previous day's allocation were weighed and new rations offered while hinds were released into large outside pens for exercise. Water was always available *ad-libitum.* As hinds calved they were individually allocated to treatment group, approximately balanced for birth date and sex. Calves were weighed and tagged within 12 to 24 hours of birth. For the duration of their 12-week lactation hinds were each given daily *ad-libitum* offers of pelleted ration (+ 5% by weight lucerne hay) that contained either low energy/low protein (LE/LP), low energy/high protein (LE/HP), high energy/low protein (HE/LP) or high energy/high protein (HE/HP). The treatment ration was introduced over 10 days following calving by replacing the "standard" pellet at a rate of 10% per day. Live weight of calves and hinds was recorded weekly. When calves were approximately 3, 7 and 10 weeks of age, calf milk water intakes (MWI) were estimated by the double isotope dilution method. Our method differed from that of Dove (1988) only in that calves were injected with approximately 0.1 mg/kg LW (c.f. 1.5 g/kg LW) deuterium oxide (D_2O), which necessitated calculations be made to account for the environmental influx of D_2O. MWI data were analysed using restricted maximum likelihood (REML) procedures, with calf as the random effect and the factorial interaction of energy and protein treatments, hind live weight, calf sex and sample day as the fixed effects. Calf growth rates for each sampling interval were analysed by least squares, fitting the factorial interaction of energy and protein treatments plus calf sex. The dependence of calf growth rate on MWI was analysed using REML, with calf as the random effect and MWI, sample day and their interaction, plus sex, as fixed effects.

TABLE 1: Dry matter content and energy/crude protein densities of pelleted rations used in this study. LE = Low energy; LP = Low protein; HE = High energy; HP = High protein.

Component	Nutrient status of ration				
	Standard	LE/LP	LE/HP	HE/LP	HE/HP
Dry matter (%)	87.7	89.3	89.3	88.8	88.8
Energy (MJ ME/kg DM)	10.5	10.3	10.3	12.5	12.3
Crude protein (g/kg DM)	140	121	241	120	212

RESULTS AND DISCUSSION

Mean daily dry matter intake (DMI) of hinds (Table 2) was significantly (P <0.001) influenced by energy density,

TABLE 2: Mean daily dry matter intake (DMI) of hinds, calf milk water intake (MWI) and calf growth rate over the 12-week study period. LE = Low energy; LP = Low protein; HE = High energy; HP = High protein; SED = Standard error of difference; LW = Live weight.

Parameter	Nutrient status of ration					
	LE/LP	LE/HP	HE/LP	HE/HP	SED	Signif.
Hind daily DMI[1] (g/kg LW)	47.2	40.5	31.8	33.1	2.53	***
Calf MWI (L/d)	2.57	2.18	2.07	2.52	0.24	*
Calf growth rate (g/d)	384	392	405	414	28.2	NS

[1] Days 10 to 84 from calving.

resulting in little overall difference in total energy intake ("energy balancing"), but wide differences in protein intake across treatment groups. As a result, there were no significant differences (P >0.05) between treatments in hind live weight change over the 12 weeks of lactation. MWI of the calves showed a significant energy/protein interaction (P <0.05) such that calves whose dams were on LE/LP and HE/HP rations had a higher mean MWI averaged over the three samples, than those whose dams were on LE/HP and HE/LP (Table 2). Average growth rate of the calves declined as they got older (525 ± 21.5, 362 ± 12.5, 344 ± 13.3 g/day from birth to 3 weeks, 3 to 7 weeks and 7 to 10 weeks of age respectively) and there was no significant difference (P >0.05) between treatments in mean calf growth rate over the 12-week study period. However, male calves grew faster on average (P <0.01) than female calves (429 vs.356 (Standard error of difference (SED) = 19.9) g/d). From birth to 3 weeks of age mean calf growth rate was significantly greater for HE (570 g/d) than for LE (473 (SED = 42) g/d; P <0.05), but there were no other significant effects of treatment on calf growth rate. There was a highly significant positive relationship (P <0.001) of calf growth rate from birth to 3 weeks on calf milk water intake, with an increase of 1 L/d in milk water intake corresponding to an increase of 113 (SED = 30; P <0.001) g/d in calf growth rate, while this relationship was not significant (P >0.05) for later samplings.

These data do not support our hypothesis that protein content of lactating hind ration is the nutrient most important in determining calf growth potential. CP content of the low protein (12% CP) diet was well below the recommended 14 to 18% CP required to maximise lactation output in sheep and cattle, and yet growth rate of calves and dams receiving the low protein diets did not differ significantly from that of calves and dams receiving the high protein (21 to 24 % CP) diets. In contrast, even though the difference between rations in energy density was quite small (12.5 vs. 10 MJ ME/kg DM), and differences in overall hind energy intake were minimised through "energy balancing" (Asher *et al.*, 2006), there were significant between treatment differences in calf growth over the first 3 weeks of lactation. Therefore, energy density of rations offered to lactating hinds is a major determinant of calf growth rate in the first 3 weeks of life. The difference in calf growth rate is likely to be underestimated in the present study because dams were able to compensate for the low energy pelleted diet and eat more. This may not be possible on summer pasture due to particle size and digesta flow rates, and also time wasted selecting higher quality components of the pasture limiting overall consumption. Calf growth rate declined as this study progressed, but milk water intake remained constant indicating that milk alone was insufficient to maximise calf growth even though milk energy density increases over the first 140 days of lactation (Arman *et al.,* 1974). While attempts were made to prevent calves accessing feed offered to their dams, casual observation indicated that, from about 8 weeks of age, some calves ingested a portion of their dam's feed. This might help explain the poor relationship between MWI and calf growth rate in later sampling times.

Energy density of rations offered to lactating hinds is a major determinant of calf growth rate in the first three weeks of life. To achieve calf growth rate genetic potential requires use of high energy forage or concentrates.

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