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Energy and protein as nutritional drivers of lactation and calf growth of farmed red deer

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ABSTRACT

Red deer calf growth rates from birth to 12 weeks of age seldom exceed 450 g/day on the best quality ryegrass/white clover pastures offered to lactating hinds over summer. However, the genetic potential for calf growth exceeds that observed on most farms. The metabolisable energy (ME) content of feed is traditionally used as the measure of feed quality for lactating hinds. The present study investigated the possibility that protein, rather than energy, content of forage may be a more important determinant of hind lactation performance and calf growth for red deer. A total of 16 mature red deer hinds pregnant to a red deer stag were calved indoors in individual pens. For the duration of their 12-week lactation they were each given daily *ad libitum* offers of pellet ration (+5% by weight of 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) (i.e. n=4 per treatment). Calves and hinds were weighed weekly during the study. The mean dry matter intake of hinds was significantly higher (by about 35–40%) for hinds receiving low energy rations (i.e. LE/LP and LE/HP groups) irrespective of protein content. This resulted in all treatment groups exhibiting the same average energy intake, providing strong evidence for 'energy balancing' of feed intake (i.e. intake compensates for energy content of feed). As a consequence of "energy balancing" there was substantial between-treatment group variance in mean protein intake (400–1200 g crude protein/hind/day). However, there was no relationship between protein intake and calf growth performance. In contrast, regression analysis of individual hind variation in energy intake and calf growth revealed that energy intake during lactation was a major determinant of calf growth performance. Overall, calf growth during the 10–12 weeks of lactation was lower than expected within the indoor system, and probably reflects a low intake of pellets by the calves themselves. The results of the study support the concepts of energy maximisation and do not support the central hypothesis of potential protein deficiency. Data from this experiment suggest that 400 g/day crude protein intake is adequate for lactation in red deer hinds.

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1. Introduction

The efficiency of venison production is, in no small part, governed by the growth performance of young deer within the first 3–4 months of life, when they are dependent on their dam for the majority of their nutrition (Beatson et al., 2000). Calf growth rates and weights during this period are largely driven by nutrition and the lactation outputs of the hind. However, very little is known about the effects of variable maternal nutrition on the quality of lactation in red deer hinds. Summer lactation often coincides with deteriorating pasture quality in the New Zealand pastoral environment (Asher et al., 1996; Nicol et al., 2000). In line with nutritional practises for traditional ruminant domesticants (sheep and cattle), farmers strive to provide pastures and supplementary feeds of high energetic value (i.e. >10 MJME/kg DM) in sufficient quantities to promote optimum lactation yields of

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hinds. This is indirectly measured by calf growth rates up to weaning (recognising that there is also a contribution of direct pasture intake by the calf from about 6 weeks of age).

The metabolisable energy (ME) content of feed for grazing ruminants has long been viewed as the primary measure of feed quality (ARC, 1980; NRC, 1985; AAC, 1990). For lactating red deer hinds, feed quality recommendations indicate a desirable ME content of about 10–11 MJME/kg DM to enable high lactation outputs (Beatson et al., 2000). For traditional perennial ryegrass/white clover pastures in New Zealand, the ability to provide feed of such quality can be difficult over summer months due to drought conditions in many regions and the natural process of seasonal pasture senescence due to reproductive partitioning of growth of grasses (Waghorn and Barry, 1987; Asher et al., 1996; Nicol et al., 2000; Litherland et al., 2002). Prevention of the reproductive state of ryegrass through judicious utilisation of leaf prior to seed head formation can lead to forage of 10–11 MJME/kg DM over summer lactation if other factors are not limiting (e.g. water availability and high temperatures). However, even under such conditions of quality pasture supply most farmers experience red deer calf growth rate caps of ~450 g/day between birth and weaning 3 months later (Beatson et al., 2000). The demonstration that the genetic potential for growth of young red deer exceeds this cap (Beatson et al., 2000) raises questions about factors limiting expression of growth potential.

In this study we questioned the assumption that energy intake is the major determinant of lactation performance of red deer, as measured by calf growth. In both sheep and cattle, crude protein (CP) concentrations in the diet of 14 to 18% are required to maximise lactation (ARC, 1980). Similarly, in red deer the estimate is 15% (NRC, 2007). Often summer pastures in New Zealand fall below this level (Litherland et al., 2002) and so we test the hypothesis that during lactation, protein availability may be limiting to red deer performance. This hypothesis is based partly on research that suggests that red deer milk may have a slightly higher protein density (7.1%–8.1%) than is the case for sheep and cattle (Arman et al., 1974; Krzywinski et al., 1980; Loudon and Kay, 1984; Csapo et al., 1987; Landete-Castillejos et al., 2000). Furthermore, the importance of protein for optimising calf growth is supported by the studies of Landete-Castillejos et al. (2001, 2003, 2005) with the demonstration that milk protein concentrations of red deer hinds were positively correlated with calf growth.

Calf milk intake and calf growth rates from this study have been published previously by Scott et al. (2008). The current paper includes the influence of feed quality on nutrient intake of hinds and the subsequent influence of hind feed intake on calf growth.

2. Materials and methods

2.1. Experimental design and composition of feed rations

The experiment was a two by two factorial design with four replicates. The factors were energy and protein. Diet energy densities were approximately 10.3 and 12.4 MJME/kg DM for low and high energy diets respectively. Diet protein densities were approximately 120 and 230 g CP/kg DM for low and high protein diets respectively. Pelletised rations were formulated to contain known but differing ratios of energy to protein content. This was achieved by altering the ratios of several primary ingredients, principally grass seed fibre, barley/wheat, molasses and soybean meal (Table 1). Four experimental rations were formulated; (1) low energy/low protein (LE/LP), (2) low energy/high protein (LE/HP), (3) high energy/low protein (HE/LP) and (4) high energy/high protein (HE/HP). The 'standard' pellet ration was a commercially available mix formulated for red deer but containing similar principal ingredients.

2.2. Animals and management

A pool of 24 mature (5–7 years old), pregnant red deer hinds (*Cervus elaphus scoticus*), with known conception dates, was selected in June 2005 (around Days 70–90 of pregnancy). They were maintained as a single group at pasture on the Invermay Agricultural Centre, Mosgiel, NZ (45° 51′S, 170° 23′ E) from early July 2005. Based on assessment of temperament, 18 of these hinds were selected in September 2005 to calve indoors within individual pens. It was anticipated that 16 of these hinds, based on successful calving, would enter the trial near their parturition date.

The 18 hinds were pre-conditioned to 'standard' pellet rations at pasture from 3 November to pen entry on 14 November. During pre-conditioning, the hinds within this group were offered amounts of the standard supplementary pellet rations increasing from 200 g/head/day to 1 kg/hind/day 10 days later. Hinds were individually housed in their pens from 14 November on total *ad libitum* concentrate rations based on 'standard pellets' and of lucerne chaff at 5% by weight of the total feed offered for roughage. Pens had a minimum area of 10 m^2, had natural lighting and *ad libitum* water. The flooring was a deep (10 cm) layer of untreated *Pinus radiata* sawdust over timber or concrete. One corner of each pen contained a calf refuge area of ~0.5 m^2 that could not be accessed by the hind.

Table 1
Energy/protein concentrations, dry matter content and ingredients of pelleted rations used in the study, classified by treatment group. LE/LP = low energy, low protein; LE/HP = low energy, high protein; HE/LP = high energy, low protein; HE/HP = high energy, high protein.

Group	Standard	1	2	3	4
Ration		LE/LP	LE/HP	HE/LP	HE/HP
Dry matter (%)	87.7	89.3	89.3	88.8	88.8
Energy (MJME/kg DM)	10.5	10.3	10.3	12.5	12.3
Protein (g/kg DM)	140	121	241	120	212
Ingredients (g/kg as fed)					
Grass seed fibre		654	509	–	–
Barley		145	–	380	–
Wheat		–	–	500	670
Molasses		40	40	40	40
Soy bean meal		–	290	20	230
Oaten chaff		60	60	–	–
Mineral mix [a]		101	101	60	60

[a] Mineral mix included bentonite, limestone, dicalcium phosphate, sodium chloride, calcined magnesite and a trace element mix, in the ratio 50:30:10:7:3:1 for low energy diets and 10:20:10:7:3:1 for high energy diets.

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