Effects of winter feed type on feed intake during the transition back to spring pasture

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Abstract

Two experiments tested the effects of different winter diets on intake and digestion of pasture by rising 1-year-old red deer returned to pasture with minimal dietary management during early spring. During May 1998 forty calves were randomly allocated to five winter feeding treatments including pasture only, silage only, 40% concentrate plus silage, 60% concentrate plus silage, and 90% concentrate plus silage. Forage intakes in the five days before and after turnout on 28th September 1998 were higher in weaners fed pasture than those fed winter diets ($P<0.05$). Of the supplemented weaners the post-turnout intake was highest from weaners fed 60% concentrate plus silage and lowest from weaners fed silage only ($P<0.05$). Pasture digestibility was higher in deer previously fed pasture than those fed silage and concentrate diets in winter (78% and 73% respectively, $P<0.05$). During May 1999 calves were randomly allocated to three winter feeding treatments including swedes only (*Brassica napus* var. Doon Major), silage only, and 60% concentrate plus silage. The deer were supplemented with *ad libitum* lucerne hay during the turnout period. During the first week, after turnout on 6th September 1999, intake was low averaging 1 kg DM/head/d. Weaners fed swedes only during winter had significantly lower intakes that the other groups ($P<0.05$). During the second week the intakes increased to be greatest in the weaners fed swedes, and those fed the silage plus concentrate diet compared to the silage only diet (1.9 and 1.8 kg compared to 1.58 kg DM/head/d respectively, $P<0.05$). The diet consisted of between 38 and 61% lucerne hay over the two week period. The digestibility of the diet was 62.8% in the first week and 75.2% in the second week. Live weight gain over the two week period ranged between 1.1 and 1.75 kg. The use of lucerne hay improved the overall result from the previous year. These results indicate that effects of winter diet during the transition period between winter and spring diets were small, though greater on poorer quality winter diets.

Keywords: *Cervus elaphus*, diet change, digestibility, food intake, live weight gain, red deer

Introduction

Many red deer in New Zealand are wintered on diets high in supplementary feeds such as silage and grain. When pasture growth exceeds demand in spring, young deer are often released to pasture without any dietary management of the transition from high levels of supplementary feed to pasture.

The rumen undergoes significant change in pH and microbial population when feed type is shifted from green forages to silage and grain (van Soest 1994). At the beginning of winter this shift can be managed through the gradual introduction of the new feed while restricting the old feed. When winter ends, however, animals are often let out onto fresh grass with no adjustment period at all. This can lead to a loss of live weight that may take some time to regain (Brelurut *et al.* 1995; Charmley & Boyd 1997). The live weight lost has previously been gained in winter at some cost, so introduces a major inefficiency in winter production.

Management of the post-winter transition period will help ensure that winter gains are not lost and that live weight gains continue, so that spring slaughter targets are more easily met. This paper examines the effects of diets of differing supplement types and feeding levels on intake and digestion of pasture by rising 1-year-old red deer returned to pasture with minimal dietary management during early spring. The first experiment examines the intakes immediately before and after turnout. The second experiment examines longer-term effects and intake recovery during the first and second weeks after turnout.

Methods and Materials

Experimental design

Male red deer calves born in late spring 1997 and 1998 at the Invermay Agricultural Research Centre, Mosgiel, New Zealand and weaned at 4 months of age were removed from pasture at 6 months of age, randomly allocated to their winter diets and fed from May until September in 1998 and 1999. Calves were treated for internal parasites with Cydectin before being assigned to their winter-feeding treatments and standard animal health procedures were followed.

Experiment 1: 1998

Experiment 1 examined the effects of winter diet on feed intake and digestibility during the five days immediately before and immediately after turnout on 28th September 1998. During May 1998 calves were randomly allocated to five winter feeding treatments in groups of eight. The five treatments were pasture only, silage only, 40% concentrate plus silage, 60% concentrate plus silage, and 90% concentrate plus silage.

Table 1 Experiment 1: Composition of the diets offered during winter and the pasture offered post-turnout in 1998 (all units g/100gDM unless otherwise stated).

	Winter Diets				
	Silage Only (n=15) mean (s.e.)	Silage plus 40 mean (s.e.)	Silage plus 60 mean (s.e.)	Silage plus 90 mean (s.e.)	Pasture (n=6) mean (s.e.)
Chemical Composition					
Dry Matter	27.9 (1.67)				
Crude protein	11.9 (0.31)				25.2 (0.70)
ADF	37.2 (0.73)				23.2 (0.42)
NDF	54.2 (0.91)				40.2 (0.65)
In-vitro digestibility	64.9 (0.89)				79.7 (0.49)
Estimated ME (MJ/kgDM)	10.5 (0.14)				11.1 (0.07)
pH	3.6 (0.01)				
Ammonia-N (mg/100gDM)	154.4 (10.2)				
Concentrate fed before turnout (kg DM/hd/d)					
Barley	0	.39	.58	.87	0
Rapeseed meal	0	.02	.03	.05	0

The silage only and concentrate plus silage treatments had *ad libitum* access to silage from covered feeders as a group. The average intake of the silage only group was used to calculate the amount of concentrate fed to the other groups. This concentrate was allocated to the other 3 groups at a metabolisable energy intake of 40, 60, and 90% of the silage only group, in addition to *ad libitum* silage. This enabled seasonal changes in intake to be accounted for before concentrate was added. The perennial ryegrass and white clover pasture was ensiled in early summer at approximately 10% seedhead emergence after being wilted for 18 to 24 hours and fine-chopped. The concentrate of 95% barley and 5% rapeseed meal was of similar protein content to the silage. This experiment is reported in full by Webster *et al.* (2001).

Food intake and digestibility were measured immediately before (23rd to 27th September) and after (28th September to 2nd October) turnout in four calves from each winter diet. Each calf was dosed on 17 September 1998 with an *n*-alkane controlled release capsule (Captec™, Fernz Health and Science Ltd, Auckland, NZ). After a six-day period rectal grab samples of faeces were taken between approximately 9:00am and 10:00am each day from September 23rd until October 2nd. All calves ran together in a single mob on perennial ryegrass and white clover pasture after turnout. A plucked pasture sample and a grab silage sample were taken on the same day as faecal samples. These samples were frozen and subsequently freeze dried.

The feed composition (Table 1) was determined for fresh silage and freeze-dried pasture by NIRS (Model 6500, NIRSystems Inc., Silver spring, MD, USA) calibrated from wet chemistry (Corson *et al.* 1999). Nitrogen concentrations of the barley and rapeseed meal were determined (Carlo Erba NA1500 Nitrogen Analyser) at regular intervals. Live weight was measured on the 17th, 21st and 23rd of September, and daily until October 2nd.

Experiment 2: 1999

Experiment 2 examined the effects of winter diet on the food intake and digestibility during the first and second weeks after turnout on 6th September 1998. During May 1999 calves were randomly allocated to three winter feeding treatment in groups of eight. Treatments included chipped swede bulbs only (*Brassica napus* var. Doon Major), silage only, and 60% concentrate plus silage *ad libitum*.

Concentrate additions were calculated relative to the silage only intakes, as they were in 1998, to account for seasonal intake variation. The feed components and composition of these diets are presented in Table 2. Feed composition was determined as per the experiment in 1998.

Each calf was dosed on 31 August 1999 with an *n*-alkane controlled release capsule and turned out to pasture on the 6th September. Endpoint was determined as the day before a 50% drop in *n*-alkane concentration occurred. Rectal grab samples of faeces were taken between approximately 9:00am and 10:00am for three days during the first and second weeks after turnout and frozen immediately, before freeze-drying. The samples from each three-day period were bulked to give one sample for each calf per week. Endpoint samples of two randomly chosen calves per treatment were taken from September

Table 2 Experiment 2: Composition of the diets before turnout and the pasture after turnout in 1999 (all units g/100gDM unless otherwise stated).

	Feed Type				
	Silage Only (n=16) Mean (s.e.)	Swedes only (n=4)	Silage plus concentrates	Pasture (n=6)	Lucerne (n=4)
Chemical composition					
Dry Matter	32.4 (5.09)	7.6 (0.23)			
Crude protein	11.8 (0.69)	20.7 (0.65)		32.7 (0.82)	23.9 (0.78)
ADF	38.3 (1.38)	19.1 (1.27)		17.2 (0.86)	28.8 (1.76)
NDF	56.1 (2.26)			32.2 (0.58)	33.2 (1.39)
Soluble carbohydrate	2.9 (0.94)	22.2 (3.29)		10.6 (0.56)	8.9 (1.47)
In-vitro digestibility	66.6 (0.93)	nd		85 †	70.1 (3.17)
Estimated ME (MJ/kgDM)	10.7 (0.16)	nd		12.3 (0.09)	9.9 (0.36)
pH	4.1 (0.15)				
Ammonia-N (mg/100gDM)	161 (22.5)				
Intake during the 10 days prior to turnout (kgDM/hd/d)					
Barley	0	0	1.6	na	na
Rapeseed meal	0	0	0.15	na	na
Forage	0.93	1.48	0.25	na	na

† Value at limit of NIRS prediction so no s.e. could be determined.

20 to 24 inclusive, and were analysed individually. Calves were grazed together in a single mob after turnout and were offered approximately 2 kg/head of lucerne hay (*Medicago sativa* L.) every second day. A plucked pasture sample and a grab lucerne hay sample were taken on the same day as faecal samples. Analysis for *n*-alkane concentration was done by Lincoln University, Department of Animal and Veterinary Science analytical laboratory based on the method of (Mayes *et al.* 1986), with the modification that samples were digested in an oven at 90°C instead of a heating block. Live weight was measured on August 23, 30th and September 6, 15 and 20th.

Data analysis

In 1998, intake (C_{32}:C_{33}) and feed digestibility (C_{35}) were calculated by dilution (Dove & Mayes 1991) using the feed and dosed *n*-alkane concentrations. Adjusting total intake for the faecal output of the measured concentrate intake with an estimated digestibility of 90g/100gDM made allowance for concentrate intakes in the pre-turnout period in 1998. In 1999, the relative intake of pasture and lucerne hay was first determined by the simultaneous equation method presented by Dove & Mayes (1991) using C_{31} and C_{33} *n*-alkane concentrations of the feed. Food intake in 1999 was then calculated after adjustment for the lucerne proportion by calculating the C_{31} and C_{33} alkane concentrations of the complete diet of each animal using the formula provided by Dove & Mayes (1991). The feed digestibility in 1999 was also calculated after adjustment for the proportion of lucerne in the diet. Recoveries of the *n*-alkanes used were those reported by Dillon (1993) being 0.826, 0.861, 0.838 and 0.882 for C_{31}, C_{32}, C_{33} and C_{35} respectively.

Individual calf intakes and live weight changes were used as replicates for each treatment. All data was analysed using ANOVA. During 1998 the data was analysed in a completely randomised design using orthogonal contrasts to compare the pasture fed calves with silage based diets, and polynomial contrasts to compare between calves coming from silage based diets. During 1999 the individual calf intake data was analysed in a completely random design using a repeated measures analysis to compare the first and second weeks after turnout.

Results

Experiment 1, 1998

Pre-turnout forage intakes (Table 3) were significantly higher in the pasture fed deer than those fed the silage-based diets (P<0.05) and declined as the proportion of concentrates in the diet increased (P<0.01).

After turnout the intake of pasture remained greater in the deer previously fed pasture than those previously fed silage based diets (Table 3; P<0.01). The intake of pasture of the deer previously fed silage based diets were highest on the silage plus 60% concentrate diet (Table 3; P<0.05) and lowest for silage only, while the 40 and 90% concentrate diets were intermediate.

The predicted silage digestibility in the silage only animals (Table 3) was similar to the estimated digestibility from NIRS analysis (Table 1), while the pasture digestibility before turnout was approximately 74%. After

Table 3 Experiment 1: Food intake and forage digestion 2 days before and 5 days after the spring turnout of rising 1-year-old male red deer fed pasture or silage plus concentrates during the winter of 1998.

	Winter Diets						Significance of diet effects	
	Silage only	Silage plus 40	Silage plus 60	Silage plus 90	Pasture only	s.e.	Pasture vs Silage based diets	Levels of concentrate feeding
Initial live weight (kg)	58.1	61.4	65.0	65.2	63.4	1.9		
Pre-turnout Intake (kg DM/d)								
Forage †	.91	.81	.85	.48	2.15	.11	**	**Linear
Forage ‡	1.08	.86	.79	.56	na	na		
Concentrate ‡	0	.41	.61	.92	na	na		
Post-turnout forage intake	1.35	1.52	2.21	1.53	2.44	.31	**	*Cubic
Forage Digestion (g/kg DM)								
Pre-turnout §	636				728	51	ǀǀ	
Post-turnout §	739	729	738	721	780	26	*	ns

† Intake estimated from faecal *n*-alkane analysis.
‡ Mean intake of the 8 animals' mob fed during the pre-turnout period.
§ Determined from *n*-alkane analysis.
ǀǀ P<0.10.

turnout pasture digestibility was lower in deer from silage-based diets than deer from pasture (Table 3; P<0.05). No significant differences were seen between levels of concentrate feeding.

Experiment 2, 1999

Forage intake during the first week after turnout was lower in deer previously fed swedes (Table 5; P<0.01) than in deer fed silage only or concentrates plus silage. Intakes of forage during the second week were significantly higher (Table 5; P<0.01) than the first week, and lowest in the silage only treatment with the other two diets being both similarly higher (Table 5; P<0.01).

The proportion of lucerne consumed during the first week was lowest in deer previously fed silage only (Table 5; P<0.01) and was similar during the second week.

The digestibilities of the forage during the first week was highest in deer wintered on silage only and similarly lower for the other two treatments (Table 5; P<0.05). During the second week the digestibility of the forage increased in all treatments (Table 5: P<0.05).

When intake was expressed as MJME/kgBW$^{0.75}$ then intake during the first week remained lowest on deer previously fed swedes and was highest in deer previously fed silage only. During the second week all intakes increased and the deer previously fed swedes had the highest intake while those fed silage based diets were similar and lower (Table 5; P<0.01).

Discussion

The use of *n*-alkanes to predict intake and digestibility of red deer has previously been reported by Fraser & Gordon (1997) and Gedir & Hudson (2000). Both have noted the utility and accuracy of the method for field-based studies. With adjustments for wastage of 10% in the group intakes and for concentrate intake the predicted intakes (Table 3) were relatively accurate when compared with that measured by group intake. The collection of plucked samples from the grazed pastures gave a good representation of the diet because of the homologous nature of the pasture offered.

The predictions of silage and pasture digestibility in experiment 1 were similar to the NIR predictions based on sheep and cattle calibrations. Therefore the differences in diet digestibility during the post-turnout period can be assumed to be accurate.

The immediate post-turnout period during both experiments showed that pasture intake was affected by previous diet. Deer fed winter diets with 60% concentrate adapted most rapidly to the pasture diet, consuming similar amounts to those deer that had been on pasture during the winter. Those on silage only had low initial intakes though recovered during the second week.

Live weight gain during the pre-turnout period (Stevens, unpublished data) was highly variable though significantly lower (P<0.05) in the silage only group (-100 g/d) when compared with the other treatments (+85 g/d). During the post-turnout period live weight change was greatest in the silage plus 60 treatment, intermediate in the pasture and silage plus 40 treatments and negative in the silage only and silage plus 90 treatments (Stevens unpublished data). This may have been a reflection of rapidly changing gut fill effects over the short period measured

Overall the live weight gain of all groups during spring 1998 (from 8 October to 18 January at slaughter) was similar (Webster *et al.* 2000). However, the extra gain of

Table 4 Experiment 2: Pasture intake of red deer during the first and second weeks after turnout in spring 1999, predicted by *n*-alkane controlled release capsules.

	Previous winter diets			
	Silage Only	Swedes only	Silage plus concentrates	s.e.
Initial live weight (kg)	59.3b†	54.1a	69.5c	1.65
Intake (kgDM/d)				
First week	1.25c†	0.61d	1.11c	0.088
Second week	1.58b	1.90a	1.80ab	
Proportion of lucerne eaten				
First week	0.38b	0.56a	0.61a	0.043
Second week	0.42b	0.58a	0.54a	
Digestibility (g/100gDM)				
First week	68.8b	59.0c	60.5c	2.24
Second week	74.5ab	78.4a	72.8ab	
ME intake (MJ/kgBW$^{0.75}$)				
First week	0.644c	0.286e	0.443d	0.022
Second week	0.883b	1.206a	0.882b	

† Means that do not share letters differ (P<0.05.)

those fed silage plus 60% concentrates continued until 12 October, and provided a significant advantage until slaughter.

The lucerne hay fed in experiment 2 provided an opportunity for the deer to manage their own transition. This was apparent in the rapid recovery of intake and digestion during the second week post-turnout. Lucerne intake was still high and live weight gain also recovered rapidly. Deer previously fed swedes had the lowest intake during week 1 but this rapidly increased. The low concentration of fibre in the swede diet would account for this initially low intake of pasture. The relatively high digestibility of the pasture meant that the degree of adjustment required in the rumen was relatively small as indicated by the rapid rise in intake by the second week. Live weight changes during the first week were greatest in deer previously fed swedes, intermediate in deer previously fed silage plus concentrates and negative in those deer previously fed silage only (Stevens, unpublished data). During the second week live weight changes were not significantly different between groups. Overall live weight change during the two weeks was positive ranging from 1.06 to 1.75 kg, with all treatments being similar (Stevens, unpublished data). The weight gain of these deer during week 1 was contrary to the intakes recorded. The overall result indicates much of the difference recorded in the short term may be attributed to variations in gut fill as intake fluctuated.

The estimated intake of the deer fed silage each year was relatively similar in the immediate post-turnout period being 1.35 and 1.25 kgDM/d for experiments 1 and 2 respectively. This provides a level of confidence to the data and indicates repeatability between years.

The digestibility of the pasture was lower in the deer just released to pasture than those that had been previously grazing. This is a natural result of the requirement for a change in the type of rumen microbes required for the digestion of a new feed type. However that adjustment was very rapid, as measured in experiment 2 where the predicted digestibility from NIR and that estimated by *n*-alkane dilution were similar by week 2. The rapid adjustment may be in part due to the opportunity for the deer to manage their own transition through the availability of lucerne hay.

In conclusion, these studies indicate that the effects of dietary transition on red deer in spring are small and short-lived, though greater on poorer quality winter diets such as silage only. Minimal dietary transition management was required when red deer were transferred from high quality winter diets to highly digestible spring grown pasture.

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