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Nutritive value of chicory (*Cichorium intybus* L) for venison production

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ABSTRACT

A grazing trial using 24 Red and 24 Hybrid (0.75 Red;0.25 Elk) deer weaners was conducted from 1st March to 12th December 1993, to compare the feeding value of chicory (*Cichorium intybus* L) with that of perennial ryegrass (*Lolium perenne*)/white clover (*Trifolium repens*) pasture for increasing venison production by one year of age. The deer were rotationally grazed using dry matter allowances of 6, 6 and 7 kg DM/head/day in autumn, winter and spring respectively. Relative to deer grazing pasture, deer grazing chicory had higher voluntary feed intake (VFI), slightly lower grazing (ie. eating) time and substantially lower ruminating time. Hybrid deer had faster liveweight gain (LWG) than Red deer and were heavier at the end of all seasons ($P<0.01$). LWG was greater on chicory than on perennial ryegrass/white clover pasture during autumn ($P<0.01$) and there were forage x genotype interactions for liveweight at the end of autumn and spring, with Hybrid deer (especially stags) being heavier when grazed on chicory. Carcass weight for Red and Hybrid stags was 64.9 and 73.0 kg when grazed on chicory and 56.6 and 57.0 kg when grazed on perennial ryegrass/white clover pasture. Grazing chicory advanced the date of first cut velvet antler by 28 days and increased the weight of total (first cut+regrowth) velvet antler. It is concluded that grazing chicory increased venison production, especially in Hybrid stags with increased growth potential, and increased velvet antler production.

Keywords: *Cichorium intybus*; Red deer; Hybrid deer.

INTRODUCTION

Puna chicory (*Cichorium intybus* L) is a perennial herb of the Asteraceae family that has been widely used as a specialist forage. Its ability to grow well under drought conditions due to its deep root has produced high forage yields (25 t DM/ha) from December to May (Hare *et al.*, 1987) in New Zealand (NZ).

A production target of the NZ deer industry is to achieve carcass weights of 50-65 kg by one year of age or less. Due to the poor alignment between pasture production and feed requirements of lactating hinds, caused by late calving (Nov/ Dec), there is a need to develop special purpose forages which have good dry matter (DM) production during summer and autumn, have deep tap roots to resist moisture stress and are of high nutritive value. Chicory fulfills these criteria, but information on chicory as a forage for deer production is limited. In preference experiments, chicory was one of the most preferred forages by Red deer, while perennial ryegrass (*Lolium perenne*) was the least preferred species (Hunt and Hay, 1990). Chicory is also substantially higher in digestibility than perennial ryegrass (Hoskin *et al.*,1995). Niezen *et al.*(1993) reported a 16% increase in growth of Red deer calves grazed on chicory during lactation relative to those grazed on perennial ryegrass/white clover (*Trifolium repens*) pasture, whilst Hunt (1993) found grazing on chicory increased weaning weight by 15%.

The present study aimed to compare the feeding value of chicory with that of perennial ryegrass/white clover pasture for increasing the growth of Red deer calves and 0.25 Elk;0.75 Red deer (Hybrid) calves from weaning to slaughter at one year of age.

MATERIALS AND METHODS

Animals and grazing management

Forty eight weaners, consisting of 24 Red deer (13 stags; 11 hinds) and 24 Hybrids (16 stags;8 hinds), were randomly allocated to graze either chicory or perennial ryegrass/white clover pasture, at the Massey University Deer Research Unit.

The trial started on 1st March 1993 and concluded on 12th December 1993.

All animals were vaccinated against clostridial infections (Coopers, Animal Health Ltd,NZ) at the start of the trial and were drenched with Ivermectin (IVOMEC, Merck, Sharp & Dohm Ltd, NZ) at 3-week intervals until end of June, then 6-weekly until slaughter on 12th December 1993. Yersiniavax vaccine (AgResearch, Upper Hutt, NZ) was given in the upper half of the neck on 1st March and 5th April 1993 to to protect deer from clinical yersiniosis caused by *Yersinia pseudotuberculosis*.

Animals were randomly allocated to graze either chicory or perennial ryegrass/white clover pasture, with DM allowances being 6, 6 and 7 kg DM/head/day during autumn, winter and spring respectively. Animals were rotationally grazed with rotation length being c.4-5 weeks. Because chicory is dormant during winter, animals from the two groups were joined and grazed on perennial ryegrass/white clover pasture (5.8 ha; 11 paddocks) over winter. They were split up again in spring into their original pasture and chicory groups. Pasture residual mass was maintained at 1700 kg DM/ha during winter.

The length of the time for the animals grazing each paddock, based on specified allowances, was calculated as follows (equation 1):

$$\text{Total (days)} = \frac{\text{herbage mass (kg DM/ha) x total area of paddock}}{\text{(Total animals/group) x (pasture allowance/deer/day)}} \quad (1)$$

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Pasture and animal measurements

Pre-grazing herbage mass (kg DM/ha) was measured before animals were introduced into each paddock, while post-grazing herbage mass was measured immediately after the animals were shifted from each paddock. On each occasion eight quadrats (0.1m^2) per paddock were cut to soil level using a hand-clipper. The herbage samples were then washed, oven-dried at 90°C for 18 h, and weighed. For laboratory analysis, eight 0.1 m^2 quadrats of fresh herbage/feed on offer were cut to ground-level from each paddock when the deer were introduced. Diet selection was estimated by daily hand-plucked plants imitating animal's selection. The samples were then pooled for each paddock.

All animals were weighed at 3-weekly intervals. At the end of the trial, all stags attaining 92 kg liveweight (50 kg hot carcass weight) were slaughtered on 12th December 1993. Hot carcass weight, rump fat cover and subcutaneous fat depth, measured as tissue depth over the 12th rib (GR; Kirton, 1989) were recorded. Carcass dressing percentage was then calculated as hot carcass weight divided by liveweight.

In autumn and spring, 24-h studies of grazing behaviour were carried out. Eating, ruminating, resting and biting rate were recorded by observation at 12-minute intervals (Jamieson and Hodgson, 1979). During the hours of darkness two 12-V spot lights were used to aid identification. Two 24h observation periods done over consecutive days were used for animals grazing each forage. Voluntary feed intake (VFI) was estimated using intra-ruminal chromium (Cr) slow release capsules (Captec Ltd, Auckland) and velvet antler was removed using standard procedures, both as described by Semiadi *et al.*(1993).

Laboratory Analysis

Forage *in-vitro* digestibility was determined using the enzymic method of Roughan and Holland (1977), whilst total nitrogen (N) was determined by the Kjeldhal procedure. Chromium analysis of faeces was done following the method of Costigan and Ellis (1987).

Data Calculation and Statistical Analysis

VFI (gOM/day) was calculated as faecal output divided by (1-OMD), where the OMD (organic matter digestibility) value was obtained from hand-plucked samples to represent diet selected (Semiadi *et al.*, 1993). Earlier studies showed that under these grazing conditions with young deer, hand pluck samples were of identical OMD to extrusa samples taken with deer fistulated in the oesophagus (Semiadi *et al.*, 1993). The duration of grazing (h/24h) for each deer species was calculated using Equation 2.

$$\text{Grazing time (h/24h)} = \frac{\sum \text{animals observed as grazing x24}}{\sum \text{animals observed}} \quad (2)$$

Total time spent ruminating/24h was calculated in a similar manner.

Liveweight gain, carcass weight, GR measurement, velvet weight, VFI, eating and ruminating times were analysed using General Linear Model (GLM) Procedure (SAS, 1987), as 2 x 2 x 2 factorial design, with two types of forage (chicory v perennial ryegrass/white clover), two genotypes (Red v Hybrid deer), two sexes (male v female) and their interactions. Age was used as a covariate for liveweight, whilst carcass weight was used as a covariate for carcass GR and rump fat cover.

RESULTS

Herbage mass and botanical composition

Pre- and post-grazing herbage masses were generally slightly higher for chicory than for perennial ryegrass/white clover pasture (Table 1), with the lowest post-grazing herbage masses being 1737 and 1843 kgDM/ha in Table 1 for perennial ryegrass/white clover pasture during winter and autumn repectively. Perennial ryegrass was the principal component of the perennial ryegrass/white clover pasture on offer, ranging from 78% in autumn to 90% in winter. The chicory sward was very pure, with chicory content of feed on offer being 89-90%. Both the pasture and chicory swards were relatively free of weeds, and for both forages samples of estimated diet selected were of similar botanical composition to feed on offer.

TABLE 1: Pre- and post-grazing herbage mass (kgDM/ha) of perennial ryegrass/white clover pasture and chicory grazed by Red and Hybrid weaner deer during autumn, winter and spring of 1993. Mean values with their standard errors.

Season	Pasture			Chicory		
	N*	Pre-grazing	Post-grazing	N*	Pre-grazing	Post-grazing
Autumn	11	2488	1843	12	3202	2138
SE		209.8	125.4		335.7	112.2
Winter[1]	21	2277	1737	0	0	
SE		75.9	58.0			
Spring	11	2988	2082	11	4110	2634
SE		217.3	117.5		533.2	310.9

* Number of samples taken per season

[1] Both pasture and chicory animals were joined and grazed together on pasture during winter.

Nutritive value of forages

Mean nutritive values for feeds during autumn and spring are given for each forage. The diet selected had a total N content of 3.40 and 3.10% DM for chicory during autumn and spring respectively, and 3.80 and 3.60% DM for perennial ryegrass/white clover pasture respectively. OMD value of diet selected for chicory and pasture was 85.8 and 77.6% respectively during autumn and 84.8 and 86.5% during spring. This indicates that both feeds were of high nutritive value.

Liveweight change

Liveweight change (LWG) of stag calves was higher than that of hind calves in all seasons (autumn, winter and spring; P<0.01; Table 2), whilst the growth of Hybrid deer was consistently greater than that of pure Red deer both during autumn and spring (P<0.01). During autumn, LWG of weaners grazing chicory was significantly higher than that of weaners grazing pasture (P<0.001), and the forage x sex interaction was significant (P<0.05), indicating a greater LWG response to grazing chicory in stags (especially Hybrids) than hinds. In spring, LWG was similar for weaners grazing chicory or perennial ryegrass/white clover pasture, but there was some indication of a forage x genotype interaction, with the growth advantage of Hybrid deer over Red deer being greatest on chicory.

The effects of sex (p=0.06) and genotype (P<0.01) on age at weaning were significant, with hybrids being on average 8 days younger than pure Red deer and stags on average 4 days younger than hinds. All liveweight data were therefore adjusted to constant age (Table 2). These age effects were probably due to differences in gestation length.

The interaction between sex and genotype was significant (P<0.05) for initial liveweight, with Red deer stags and Hybrid hinds being heaviest. Weaner deer that had grazed on chicory tended to have heavier liveweight than those that had grazed pasture at the end of autumn, at the end of winter and at the end of spring. Hybrid deer were heavier than pure Red deer at the end of all three seasons (P<0.05). The genotype x forage interaction was significant at the end of both autumn and spring (p=0.07), explained by Hybrid deer (especially stags) being heavier when grazed on chicory compared with perennial ryegrass/white clover pasture.

Effects of treatments on carcass production

Most stags grazing either forage attained the target slaughter liveweight of 92 kg (Table 3). Stags grazing chicory had significantly higher carcass weight (P<0.001) and dressing out percentage (P<0.001) than those grazing perennial ryegrass/white clover pasture, whilst Hybrid stags had significantly higher carcass weight (P<0.05) than pure Red deer stags. The interaction between forage and genotype was significant (p=0.06) for carcass weight, with Hybrid stags showing a greater response on chicory than on perennial ryegrass/white clover pasture. After being adjusted to equal carcass weight, carcass subcutaneous fat depth (GR) tended to be higher (p=0.09) for stags grazing chicory than for stags grazing perennial ryegrass/white clover pasture; there was no interaction between genotype and forage. The interaction between genotype and forage for rump fat cover was significant (P<0.05), with Hybrid stags grazing chicory having higher rump fat cover compared to the other groups.

TABLE 3: Carcass production from stags grazing either perennial ryegrass/white clover pasture or chicory and attaining slaughter liveweight (92kg) by one year of age.

Forage	Pasture		Chicory		SEM
Genotype	R	H	R	H	
Number of animals	7	8	6	8	7
No.of animals attaining target slaughter LW	7	7	6	8	
(%)	(100)	(88)	(100)	(100)	
Carcass weight (kg)	56.6	57.0	63.2	73.0	2.34
Dressing percentage(%)	54.1	54.1	58.4	58.6	0.45
GR tissue depth (mm)[1]	3.2	3.1	5.7	7.1	0.70
Rump fat cover (mm)[1]	109.1	105.9	105.7	125.7	3.95

R = pure Red deer
H = Hybrid (0.25 Elk; 0.75 Red)
[1] after adjustment to equal carcass weight

Grazing behaviour

Organic matter intake (OMI) of deer grazing chicory was higher than that of deer grazing perennial ryegrass/white clover pasture during autumn (1479 v 1170 gOM/d;P<0.05) and spring (4036 v 3502 gOM/d;P<0.05). Stags had higher OMI than hinds in autumn (1416 v 1233 gOM/d;p=0.10) and in spring (4157 v 3382 gOM/d;P<0.005). Weaner deer grazing chicory spent significantly less time eating in autumn (8.7 v 10.9 h/24h;P<0.05), and in spring (8.7 v 10.3 h/24h ;P<0.01) than those grazing perennial ryegrass/white clover pasture. Deer grazing chicory spent less time ruminating in autumn (1.6 v 3.5 h/24h;P<0.01) and in spring (2.0 v 3.3 h/24h;P<0.01) compared to those grazing pasture. Bite rate of weaner deer grazing chicory was lower in autumn (34.1 v 52.1 bites/min;P<0.001) and in spring (32.6 v 46.7 bites/min;P<0.001) than those grazing perennial ryegrass/white clover pasture.

TABLE 2: Liveweight and liveweight gain of Red and Hybrid weaner deer grazed on either perennial ryegrass/white clover pasture or chicory during autumn, winter and spring of 1993.

Forage	Pasture				Chicory				SEM
Sex	Stag		Hind		Stag		Hind		
Genotype	R	H	R	H	R	H	R	H	
Number of animals	7	8	6	4	6	8	5	4	6
Mean initial age (days):	97.0	88.6	100.2	94.1	97.0	88.6	100.2	94.1	3.1
Mean liveweight (kg)[1]:									
Initial (1.3.93)	50.4	47.4	44.8	49.1	50.4	47.4	44.8	49.1	2.3
End autumn (8.6.93)	68.4	67.6	60.8	65.5	74.3	78.8	63.5	70.8	3.2
End winter (20.9.93)	87.4	83.3	71.8	77.4	88.4	99.6	75.1	81.4	4.0
End spring (12.12.93)	108.5	105.3	86.1	96.1	110.8	124.9	85.8	100.0	4.7
Liveweight gain (g/d):									
Autumn (99 days)	178	203	157	264	246	318	193	220	17.2
Winter (100 days)	171	146	98	113	127	193	103	93	13.6
Spring (79 days)	260	271	174	223	255	310	141	232	21.1

[1] Adjusted to equal age.
R = pure Red deer
H = Hybrid (0.25 Elk;0.75 Red)

Velvet antler production

Relative to grazing on perennial ryegrass/white clover pasture, grazing on chicory advanced the mean date of first cut velvet antler by 28 days ($P<0.01$), tended to increase the weight of first cut velvet but significantly increased the combined weight of first cut and regrowth velvet ($P<0.01$;Table 4). First cut velvet was removed on average 14 days later for Hybrid than for pure Red deer stags. There were no forage x genotype interactions for any of the velvet measurements.

TABLE 4: Velvet antler production from Red and Hybrid yearling stags grazing either perennial ryegrass/white clover pasture or chicory during 1993.

Forage	Pasture		Chicory		SEM
Genotype	Red	Hybrid	Red	Hybrid	
Total No.of stags	7	8	6	8	7
Stags producing velvet (%)	100	75	83	100	
Mean date of first cut	29 Oct	15 Nov	4 Oct	14 Oct	7.9
First cut (g)	280(7)*	269(6)	349(5)	399(8)	58.2
Regrowth (g)	368(3)	160(1)	379(5)	438(7)	67.2
First cut and regrowth (g)	438(7)	296(6)	727(5)	783(8)	103.7

* Number of stags per group

DISCUSSION

The most important results in the present study were the greater carcass weights of deer grazing chicory compared to those grazing perennial ryegrass/white clover pasture, and the greater carcass weight responses of Hybrid deer on chicory than on perennial ryegrass/white clover pasture, indicating that the superior genetic potential of Hybrid stags for growth can best be expressed when grazing a forage with high nutritive value. Components of the superior carcass weight on chicory include a greater carcass dressing percentage than for deer grazing perennial ryegrass/white clover pasture and superior growth rates relative to pasture-fed deer during autumn. Studies with red clover (Niezen *et al.*,1993;Semiadi *et al.*,1993) have shown that grazing on this plant increased deer carcass production through increasing carcass dressing percentage and by increasing LWG, mainly during summer and autumn.

Reasons for the superior growth on chicory include a higher VFI and slightly greater OMD of the diet selected. Data from grazing behaviour observations showed that deer grazing chicory spent only slightly less time eating but substantially less time ruminating than those grazing pasture. This result is in agreement with Hoskin *et al.*(1995) who showed that deer fed freshly-cut pure chicory indoors spent similar time eating (361 v 379 min/24h) but markedly less time ruminating (33 v 270 min/24h) than those fed perennial ryegrass. The function of the rumination process is to reduce particle size until a critical size is reached, at which time there is a high probability of leaving the rumen (Ulyatt *et al.*,1986). For deer this size has been defined as passage through a 1mm sieve (Domingue *et al.*,1991). The shorter ruminating time in deer fed chicory suggests that particles of this feed can be broken down to the critical particle size and passed out of the rumen faster than perennial ryegrass, and this needs to be studied in future experiments.

Stags grazing chicory had higher total velvet weights and an earlier first velvet cut, compared to those grazing perennial ryegrass/white clover pasture (Table 4). Fennessy and Suttie (1985) stated that pedicle initiation is highly correlated with body weight and is dependent on the level of nutrition. Suttie and Kay (1983) reported that stags fed to appetite advanced pedicle initiation by 12 weeks compared to those under restricted feeding, whilst Fennessy (unpublished cited by Fennessy and Suttie, 1985) reported that feeding pelleted feed (barley-lucerne-linseed) *ad libitum* advanced pedicle initiation of stags by 6 weeks compared to those given meadow hay. Effects of chicory feeding on velvet antler production can perhaps be explained by the associated increase in liveweight, particularly during autumn, which may have advanced pedicle initiation.

If chicory is to be included in deer production systems under grazing conditions, it is very important to maintain the plants in the vegetative state, as an increase in proportion of stems during seed-setting in the reproductive state leads to a decrease in forage quality. Li *et al.*(1994) reported that the primary reproductive stem of chicory was controlled by grazing, while the secondary reproductive stem, which lignifies more than the primary stem, was not controlled by grazing. In order to maintain chicory in the the vegetative state, the primary stem requires hard grazing but the secondary stem requires mechanical topping due to its poor palatability. Lax grazing of chicory with sheep resulted in a lower leaf:stem ratio compared to medium, hard and very hard grazing (Li *et al.*, 1994). In the present study hard grazing was done by follow up grazing with non-experimental deer.

In conclusion, carcass weights of 50-65 kg can be obtained with grazing stags by less than one year of age. Hybrid stags showed greater growth and carcass production than pure Red stags. Grazing on chicory increased both carcass and velvet antler production compared with stags grazed on perennial ryegrass/white clover pasture. Deer grazing chicory were shown to have higher VFI and lower ruminating time compared to those grazing perennial ryegrass/white clover pasture, suggesting faster rumen particle breakdown occurring for chicory.

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