Grazing behaviour and species selection of heifer calves fed different forages.

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Abstract

The aim of this experiment was to determine whether there was a difference in the behaviour of calves grazing different forages. Weaned dairy heifer calves (n = 64) were assigned to two different forage feeding treatments: ryegrass pasture and a clover-herb mix. Behavioural observations were recorded every 10 minutes over a 72 h period. Behaviours recorded were standing, walking, lying or sitting, grazing, ruminating, drinking/grooming, playing and various combinations of these. Calves grazing pasture spent more time lying and ruminating compared to calves grazing the clover-herb mix (34.6% vs 16.7%), and less time standing and grazing (17.2% vs 32.2%). Calves were less active from late evening and early morning and more likely to be ruminating earlier in the day and grazing later in the day. Plant selection (measured as plant disappearance rate) was determined in calves grazing the clover-herb mix. Red clover had the highest disappearance rate on all days compared to other species ($P<0.05$). Plantain, chicory and white clover eaten on day one did not differ in proportions eaten, but by day three less red clover and chicory remained compared to plantain and white clover ($P<0.05$).

Keywords: calf; grazing behaviour; diet selection; herb forage

Introduction

Having replacement heifers reach target live weights at specific ages is important because this affects the age at which heifers reach puberty, thus influencing future reproductive performance and milk production (Bryant et al. 2004). Previous studies have reported greater growth rates of six-month-old dairy heifers fed a clover-herb mix or lucerne compared with a ryegrass/white clover pasture over the summer (January-April) period (de Clifford et al. 2014; Handcock et al. 2015). A combination of red and white clover with chicory and plantain results in a sward that is more productive with a longer growing season than any one of the species individually (Kemp et al. 2010). These alternative forages have greater metabolisable energy, digestibility and crude protein percentage along with lower fibre content than pasture, contributing to increased growth rates in lambs and heifer and bull calves (Kemp et al. 2010; Berry 2013; de Clifford et al. 2014; Cranston et al. 2015; Handcock et al. 2015). However, there is no information on calf behaviour or plant selection when grazing a clover-herb mix.

The aim of this study was to determine if grazing a clover-herb mix (CH: chicory, plantain, red and white clover), rather than a ryegrass pasture (RG) would influence heifer grazing behaviour. Additionally, the opportunity was taken to determine whether there was preferential selection of plant species within the clover-herb mix.

Materials and methods

Animals

Weaned dairy heifer calves (n = 64, average age 138 days ± 15.1 days) were assigned to two different forage feeding treatments: RG (live weight 147.6 ± 1.99 kg) and CH (live weight 145.8 ± 1.99 kg) during December 2014. Calves grazed an established perennial ryegrass (*Lolium perenne*) pasture or a second year mix of red clover (*Trifolium pratense*), white clover (*T. repens*), chicory (*Cichorium intybus*) and plantain (*Plantago lanceolate*). Treatment groups were balanced for date of birth, breed, liveweight breeding value and a prior milk feeding treatment (high or low milk feeding; Cardoso et al. 2015). Calves were weighed on December 8th and December 19th, with grazing behaviour being observed between these time points.

Behaviour observations

Behavioural observations were recorded every 10 minutes over a 72-hour period. Behaviours were selected based on previous behavioural research in grazing cattle (Back & Macdonald 2007), and included standing, walking, lying, grazing, ruminating, and combinations of these. Playing and drinking/grooming were combined due to low numbers of observations. This enabled a daily profile to be created for each heifer that was used to evaluate if there were differences in time spent grazing, standing, lying and ruminating between the groups of calves grazing different forages.

Feed analysis

Hand-plucked samples were taken pre-grazing for herbage quality analysis, which would represent herbage intake of the grazing calves (Table 1). Samples were analysed using an *in vitro* digestibility analysis (Roughan & Holland, 1977) to measure: *in vivo* organic matter digestibility (OMD%), dry matter digestibility (DMD%), and digestible organic matter in the dry matter (DOMD%). Samples were analysed by wet chemistry to measure

Table 1 Nutritional analysis of clover-herb mix (CH) and ryegrass pasture (RG) offered to grazing heifer calves.

	DM%	CP%	ME	NDF%	ADF%	OMD%	DMD%	DOMD%
CH	12.5	23.8	11.6	22.8	16.0	81.9	78.2	72.5
RG	24.3	28.8	10.6	36.6	19.4	73.9	71.6	66.2

DM% = dry matter content; CP% = crude protein content; ME = metabolisable energy (MJME/kgDM); NDF% = neutral detergent fibre content; ADF% = acid detergent fibre content; OMD% = organic matter digestibility; DMD% = dry matter digestibility; DOMD% = digestible organic matter content of dry matter.

crude protein (CP). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) content were determined by the method of Van Soest et al. (1981). Metabolisable energy (ME) was calculated as ME = DOMD% x 0.16 (Geenty et al. 1987).

Diet selection

Diet selection was determined for calves in the CH treatment. Twenty transects identified two hundred plants of interest, balanced for the proportion of species in the sward (Somasiri 2014). Relative abundance for each species in the sward were: 34.3% chicory, 18.9% plantain leaf, 16.9% plantain seed head, 12.1% red clover, 7.4% dead matter, 6.1% white clover, and 1.2% weeds. Of the four species of interest, the percentages of chicory, plantain, red clover, white clover and plantain (leaf only) were 48%, 26.5% 17% and 8.4%, respectively. This resulted in 96 chicory, 53 plantain, 34 red clover and 17 white clover plants being tagged.

Diet-selection was recorded over a 72 h period and each tagged plant was checked at 24 h intervals to determine the proportion of each individual original plant remained relative to an ungrazed plant. This was assessed in 25% increments. Calves had been grazing their respective diets since weaning (approximately six weeks). A new break was allocated at the start of the experiment. Calves remained in this break for the duration of the study. Pre-grazing masses were CH: 5000 kg DM/ha and RG: 4199 kg DM/ha. Post-grazing residuals were 4187 kg DM/ha for CH and 3958 kg DM/ha for RG, allowing *ad libitum* intake over the three days.

Data handling

The following variables were derived from behavioural observations: occurrence of the behaviour at each time point, coded as a binomial trait (observed or not) for each of the 12 behaviours recorded. For each 6 h period (early morning: midnight - 6 am; late morning: 6 am - noon; afternoon: noon - 6 pm; evening: 6 pm - midnight) of each day, total time spent performing each behaviour was calculated, assuming that the behaviour observed at each time point was continued for the following 10 minutes until the next observation.

Statistical analysis

Data were analysed using SAS 9.3 (SAS Institute Inc., Cary NZ, North Carolina). The probability of the behaviours being observed at least once at each time point in the day was analysed using a generalised model that included the fixed effects of forage treatment (CH or RG) and date of measurement, with time of day (in 10 minute intervals) fitted as a covariable and the random repeated effect of calf. The time per 6 h period that calves spent performing a particular behaviour and the probability of the behaviours being observed at least once during each period in the day were analysed using generalised models. Both models included the fixed effects of treatment, date of measurement and 6 h period (early morning, late morning, afternoon, evening). Plant disappearance (average proportion of the original plant removed by grazing) was investigated using a general linear model that included the fixed effect of day and the interaction between day and species (Somasiri 2014).

Results

Average daily gain was not different between the two treatments ($P>0.05$; 1.08 ± 0.03 kg for RG calves and 1.06 ± 0.03 kg for CH calves). CH calves spent a greater percentage of their day standing (8.3% vs 6.1%; $P<0.05$) and standing+grazing (32.2% vs 17.2%; $P<0.05$) than RG calves (Table 2), which spent a greater amount of time lying+ruminating (34.6% vs 16.7%; $P<0.05$) and standing+ruminating (3.1% vs 1.2%; $P<0.05$) than CH calves. The time spent walking, playing and walking+grazing was similar between treatments ($P>0.05$).

Behaviour patterns for standing, standing+ruminating, lying+ruminating and standing+grazing over an average 24 hr period for both treatments are presented in Figure 1. There is a peak in standing+ruminating (Figure 1a) within RG at 08:00 – 0.900 (17% of calves), whereas within CH calves, this peak occured at 15:00 – 16:00, when 22% of CH calves were standing+ruminating.

RG and CH calves had bouts of lying+ruminating throughout the day (Figure 1b). More calves in RG than in CH were observed lying+ruminating in each bout, with almost 80% of RG calves lying+ruminating at 23:00 whereas no more than 50% of CH calves were lying+ruminating at any time point.

The standing+grazing behaviour (Figure 1c) was performed in CH more frequently than in RG. Little to no grazing occurred between 21:00 and 05:00 in either treatment, with the exception of one peak of 33% of calves on RG grazing between 02:00-03:00.

Calves in CH were seen standing more often than those in RG (Figure 1d).

Behaviour observation probabilities are presented in Table 3. A greater proportion of RG than CH calves were observed standing, drinking/grooming, standing+grazing,

Table 2 Mean number of minutes per day spent doing each behaviour by calves grazing a clover-herb mix (CH) and ryegrass (RG) pasture.

Treatment	Behaviour[1]									
	S	D	SR	SG	W	WG	L	LR	P	LG
CH	119[a]	19[a]	18[b]	463[a]	60[a]	26[a]	478[a]	241[b]	11[a]	6[a]
RG	88[b]	10[b]	44[a]	247[b]	52[a]	30[a]	460[b]	498[a]	10[a]	2[b]

[a, b] means with different letters in the same columns are significantly different (P<0.05)

[1] standing (S); drinking/grooming (D); standing, ruminating (SR); standing, grazing (SG); walking (W); walking, grazing (WG); lying/ sitting (L); lying/ sitting, ruminating (LR); playing (P); and lying, grazing (LG).

Figure 1 Proportion of calves expressing behaviour in either a herb-clover (——) or ryegrass pasture (·····) treatment over an average 24 h, these behaviours are a) standing, ruminating b) lying, ruminating c) standing, grazing d) standing.

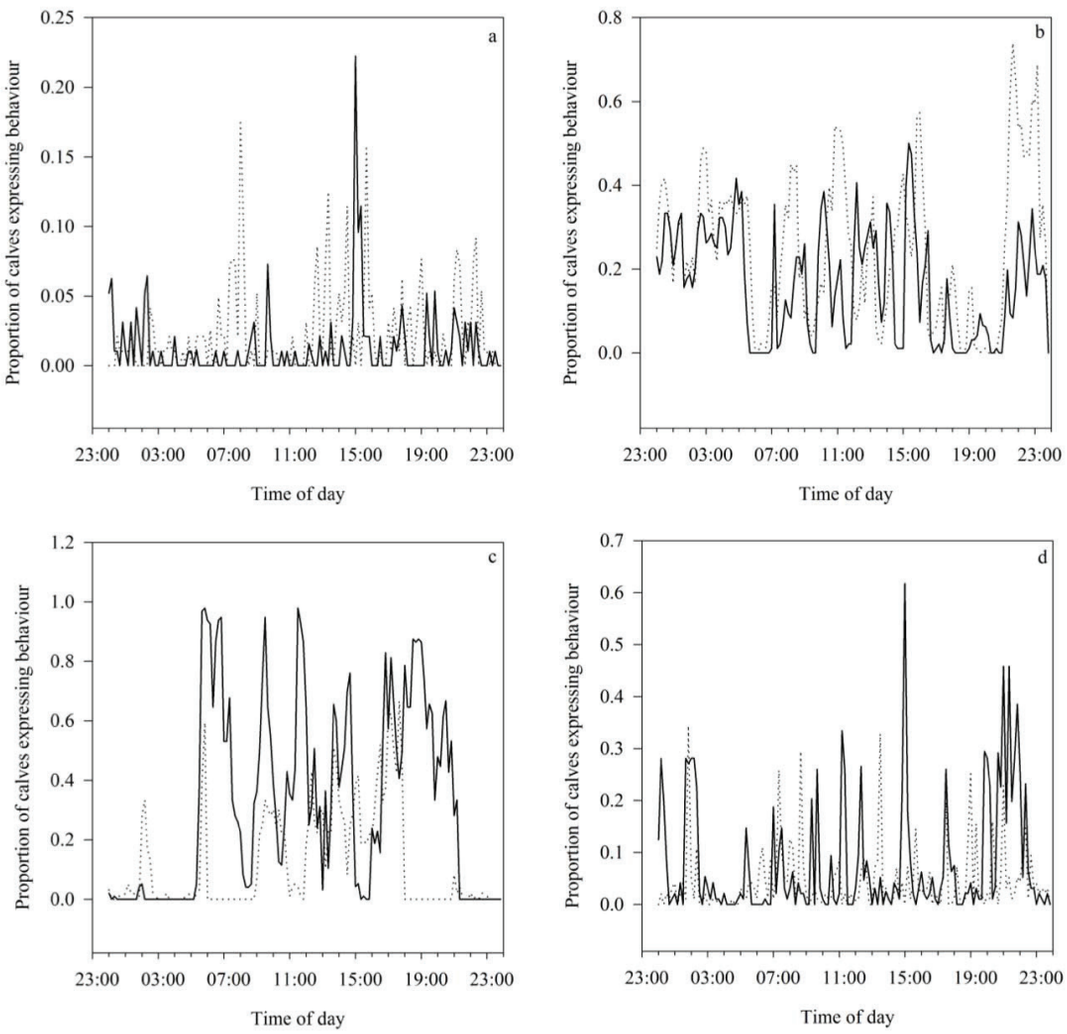

Table 3 Probability of a behaviour being observed at least once per day ± SEM on herb-clover mix (CH) compared to ryegrass (RG) pasture, and probability of a behaviour being observed at least once during a 6 h period (early morning: 12am-06:00, late morning: 06:00-12:00; afternoon: 12pm- 18:00; evening: 18:00-24:00) ± SEM.

Behaviour	Treatment		Period			
	CH	RG	Early morning	Late morning	Afternoon	Evening
Standing	0.41±0.005[b]	0.46±0.003[a]	0.02±0.003[w]	0.41±0.012[x]	0.73±0.013[y]	0.92±0.010[z]
Lying	0.51±0.005[a]	0.48±0.004[b]	0.98±0.004[z]	0.51±0.011[y]	0.21±0.128[x]	0.07±0.008[w]
Grazing	0.29±0.003[b]	0.36±0.003[a]	0.01±0.001[w]	0.36±0.010[x]	0.64±0.008[y]	0.85±0.010[z]
Ruminating	0.18±0.005[b]	0.27±0.004[a]	0.58±0.021[z]	0.25±0.009[y]	0.17±0.008[x]	0.07±0.005[w]
Drinking/grooming	0.01±0.001[b]	0.02±0.001[a]	0.01±0.002 [z]	0.03±0.003[x]	0.02±0.002[y]	0.02±0.005[xy]
Playing	0.01±0.001[a]	0.01±0.001[a]	0.01±0.002[z]	0.01±0.001[z]	0.01±0.001[z]	0.01±0.001[z]
Walking	0.04±0.002[a]	0.03±0.001[b]	0.01±0.001[x]	0.06±0.004[z]	0.07±0.003[z]	0.04±0.008[y]

[a, b] means with different letters across treatment rows are significantly different in treatment columns (P<0.05).

[w, x, y, z] means with different letters across period rows, are significantly different in the period columns (P<0.05).

Table 4 Mean ± SEM of the disappearance (proportion of plants lost from the sward through grazing) of each plant species in the clover-herb mix on days 1, 2 and 3 of the sward being grazed.

	Day of experiment		
Species	Day 1	Day 2	Day 3
Chicory	$0.29 \pm 0.05^{a\,z}$	$0.60 \pm 0.05^{a\,y}$	$0.83 \pm 0.04^{b\,x}$
Plantain leaf	$0.25 \pm 0.06^{a\,z}$	$0.42 \pm 0.07^{b\,z}$	$0.57 \pm 0.06^{b\,y}$
Red Clover	$0.66 \pm 0.09^{a\,xy}$	$0.70 \pm 0.09^{a\,y}$	$0.93 \pm 0.07^{b\,yz}$
White Clover	$0.28 \pm 0.13^{a\,z}$	$0.27 \pm 0.10^{b\,z}$	$0.43 \pm 0.09^{a\,z}$

[a, b] means with different letters within rows denote significant differences in each row (P<0.05).

[y, z] means with different letters within columns are significantly different (P<0.05).

standing ruminating or lying+ruminating. Alternatively, a greater proportion of CH calves than RG calves were observed lying or walking (P<0.001).

Standing was more likely to be observed after midday, rather than before midday (92.2% vs 1.5% probability of being observed at least once; P<0.001). Lying was more likely to be observed during the early morning, (98% probability; P<0.05) than during any other period of the day, and standing+grazing occurred most frequently during late evening (85% probability; P<0.05). Standing+ruminating or lying+ruminating were more likely to be observed in the early morning (57% probability; P<0.05) than at any other time of the day.

Plant selection (measured by plant disappearance rate) is presented in Table 4. Red clover had the highest rate of disappearance on any day compared with other plant species (P<0.05). Disappearance of plantain, white clover and chicory did not differ from each other on day one, but by day three less of both the red clover and chicory (P<0.05) than plantain and white clover remained.

Discussion

The objective of this experiment was to determine whether grazing CH compared with RG influenced grazing behaviour. Calves grazing CH spent more time standing and grazing but less time ruminating and lying than calves grazing RG. Herb forages, either in pure swards or clover-herb mixes have been shown to have faster ruminal degradation (Burke et al. 2000) and lower rumen retention time (Hoskin et al. 1995). Whereas, sheep and cattle fed a high fibre poor-quality pasture required greater rumination time to breakdown feed particles to a size suitable for passing through the reticulo-omasal orifice (Welch & Smith, 1969; 1970). While the pasture in this experiment would not be considered poor quality, it did contain a greater amount of fibre and consequently, a lower digestibility, than the clover-herb mix, contributing to the longer rumination time of calves grazing pasture. The lower DM%, fibre and higher digestibility of CH was consistent with other studies (Berry 2013; de Clifford et al. 2014; Cranston et al. 2015; Handcock et al. 2015) and would have contributed to the decreased time ruminating and increased time spent grazing by CH calves.

In both treatments, calves were less active from late evening to early morning, and were more likely to be ruminating earlier in the day, and grazing later in the day. There is little published literature on calf grazing behaviour. Grazing and ruminating times of calves were similar to those of adult cows, as were the patterns of grazing during the day and resting at night (McArthur 1951; Metz 1975; Tucker et al. 2007). In the present experiment, calves spent a similar amount of time lying and ruminating but less time grazing than did adult dairy cows in a previous experiment (Back & Macdonald 2007). Cows strip-grazing pure herb swards (chicory or plantain, up to 60% of diet) spent the same time grazing but had reduced rumination time compared with cows strip-grazing pasture (Gregorini et al. 2013). The smaller amount of time CH calves spent ruminating is also consistent with studies in deer (Hoskin et al. 1995).

Despite different times spent grazing and ruminating, average daily growth rates of calves in the two treatments were the same. This is in contrast to studies grazing the clover-herb mix during summer (Berry 2013; de Clifford et al. 2014; Cave et al. 2015; Handcock et al. 2015) and may indicate that there was no increase in nutritive value of the diet with using the clover-herb mix at this stage of the season.

Selection is defined as what an animal actually eats from a mixed sward and is dependent on availability, accessibility and palatability of the species (Hodgson 1979). In this study, selection for red clover was greater than for chicory, which was greater than for plantain and white clover. While there is little information about grazing selection in calves, this is consistent with studies that have shown that sheep and deer select red clover and chicory over white clover and plantain (Parsons et al. 1994; Cosgrove & Hodgson 2002; Pain et al. 2010; Somasiri 2014; Cave et al. 2015). Low selection of white clover was reported by Cave et al. (2015) in a study with lambs. The vertical availability of the plant in the sward is limited for white clover compared with other species in the mix at the height of the sward being grazed. If more white clover was present in the upper strata of the sward, this may alter the species preference.

Understanding calf selection for forage species and its effect on behaviour and subsequent intake will assist farmers in providing a diet that can increase dry matter intakes to help meet growth targets in grazing calves.

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