BRIEF COMMUNICATION: Effect of pre-weaning milk allowance on post-weaning behaviour of heifer calves on pasture

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Abstract

The objective of this study was to assess how pre-weaning milk allowance influences the grazing and rumination behaviour of dairy heifers on pasture after weaning. Group-housed heifer calves (n=28) were fed milk replacer at a low-allowance (LA; 10% of initial live weight), high-allowance (HA; 20% of initial live weight), and *ad-libitum* (ADLIB; free access) until 93 days of age. Heifers were then given access to pasture at 100 days of age, and were observed at 101, 108, 122 and 127 days of age. At 101 days of age, LA calves spent more time ruminating than HA and ADLIB calves, and spent less time grazing than HA calves ($P<0.05$). The time spent on each activity in subsequent weeks was the same among treatments. This indicates that any differences in foraging and rumination behaviour caused by pre-weaning milk allowance disappeared within a few weeks after weaning.

Keywords: milk; feeding; rumination; grazing

Introduction

Feeding calves more milk can increase growth rates in early life and may lead to improved long-term performance (Khan et al. 2016). However, greater milk allowance depresses the intake of solid-feed during the milk-feeding phase, which can slow down rumen development and lead to poor growth rates after weaning, particularly if weaning is abrupt (Khan et al. 2011). In New Zealand, young calves are often given access to pasture shortly after they are weaned, or while milk is still being fed. The ability of calves to successfully transition to grazing pasture is important for their performance after weaning. The time spent grazing, ruminating and idling can provide an indication of the ability of calves to consume forage (Aikman et al. 2008). The objective of this study was to determine the effect that pre-weaning milk allowance may have on grazing and rumination behaviour of calves after they have been weaned and given access to pasture.

Methods

The calves in this study were group-reared using an automatic milk-and starter-feeding system (CalfSMART, Palmerston North, New Zealand) in a large study previously described by Groenendijk et al. (2018). A subset of heifer calves (Holstein-Friesian x Jersey, n=28) of similar age were selected from three pre-weaning milk-allowance treatments which were: low allowance (LA; n=10) milk replacer fed at 10% of their initial live weight; high allowance (HA; n=9), milk replacer fed at 20% of their initial live weight; and *ad libitum* (ADLIB; n=9) access to milk replacer.

A commercially available milk replacer (150 g/L) was fed to all calves from 12 to 93 days of age. Calves were weaned gradually over 14 days, beginning at 79 days of age by linearly reducing the volume of milk replacer based on each calf's mean consumption in the three days prior to the start of weaning. Calves had *ad libitum* access to clean drinking water and to a pelleted calf starter (20% crude protein) along with *ad libitum* access to ryegrass baleage from three weeks of age. Calves were housed indoors until 100 days of age, at which point they were given free access to pasture and kept as a single mob in an area of approximately two hectares. Calf starter remained available *ad libitum* from automatic feeders for a further week on pasture and was then gradually reduced to zero over two weeks.

Observations to monitor behaviour were made on four days over a four-week period at 101, 108, 122 and 127 days of calf age. Calves were recorded at five-minute intervals by three observers from 8am to 4pm. Calves were recorded as either grazing (actively consuming pasture), ruminating (jaw movements, not consuming pasture), idling (sitting or standing stationary whilst not ruminating or grazing), active (moving, with no rumination), drinking water (actively consuming water) or eating calf starter (head inside feeding stall). Total time spent drinking water and consuming calf starter was negligible and not different between treatments ($P>0.05$) and is not presented.

Live weights of all calves were recorded at 101 and 126 days of age using a digital weigh scale monitor attached to a double load-bar scale. Blood samples for β-hydroxybutyrate analysis as described by Groenendijk et al. (2018) were collected from the jugular vein of calves (LA; n=9, HA; n=6, ADLIB; n=9) after milk weaning at 100 days of age, and after calf starter weaning from all calves at 121 days of age. Pasture samples were collected by pluck sampling and composition determined according to the methods of AOAC (1990), and herbage mass was measured using a rising plate-meter.

Behaviour parameters and liveweight data were analysed with the PROC MIXED procedure in SAS (v9.4, SAS Institute Inc, Cary, NC, USA), with pre-weaning treatment as a fixed effect and calf nested within treatment as a random effect. A general linear model was used to analyse β-hydroxybutyrate, average daily gain (ADG),

milk replacer intakes and calf-starter intakes, with pre-weaning treatment as a fixed effect.

Results and discussion

Herbage mass was high throughout the study period (3000-5500 kgDM/ha), and would have ensured that pasture availability was unrestricted, but pasture quality deteriorated as indicated by a gradual decline in the metabolizable energy content of the pasture from 10.3 to 9.0 MJME/kgdm, and crude protein content from 15.0% to 9.7% over the study period. This may have affected the ADG of calves, particularly after week four when calf starter feeding was stopped.

At the beginning (100 days of age), ADLIB calves in this study tended (P=0.087) to be heavier than HA and LA calves (Table 1). In the overall study that included data

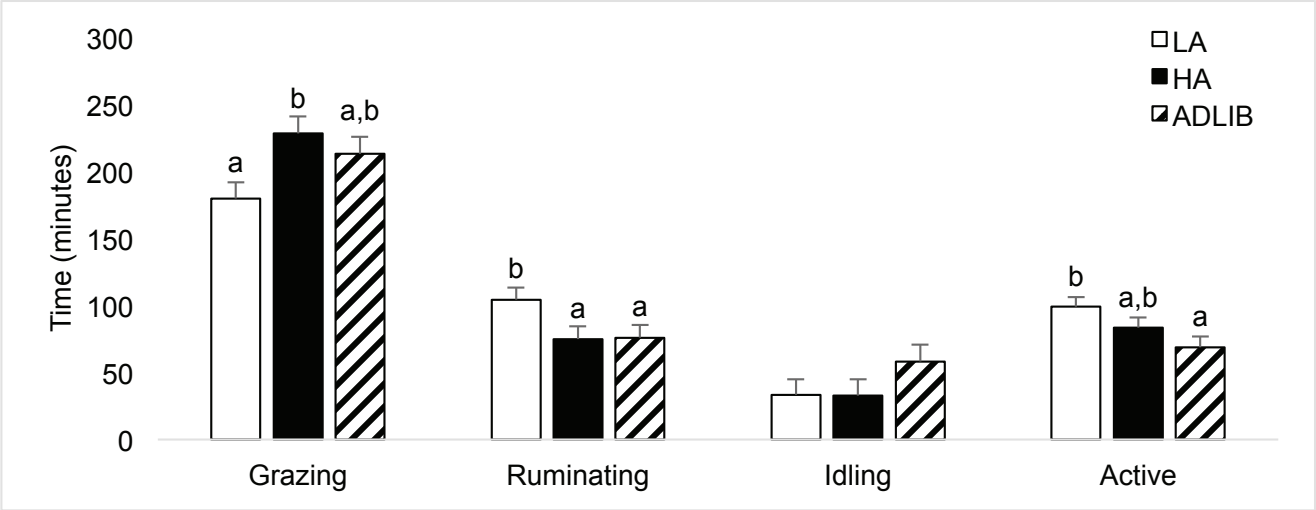
Table 1 Least-squared means (±standard error) of calf live weights at the beginning (one week after weaning) and end of the study (five weeks after weaning), and average daily gain (ADG) over the four-week study period.

	LA	HA	ADLIB	P-value
Pre-weaning milk intake (litres/day)	3.6±0.28[a]	6.2±0.28[b]	9.3±0.26[c]	<0.001
Initial weight (kg)	94.7±4.5	93.1±4.7	104.6±4.7	0.16
Final weight (kg)	109.5±4.5[a]	111.7±4.7[a]	124.5±4.7[b]	0.07
ADG (kg/day)	0.57±0.10	0.72±0.10	0.76±0.10	0.36

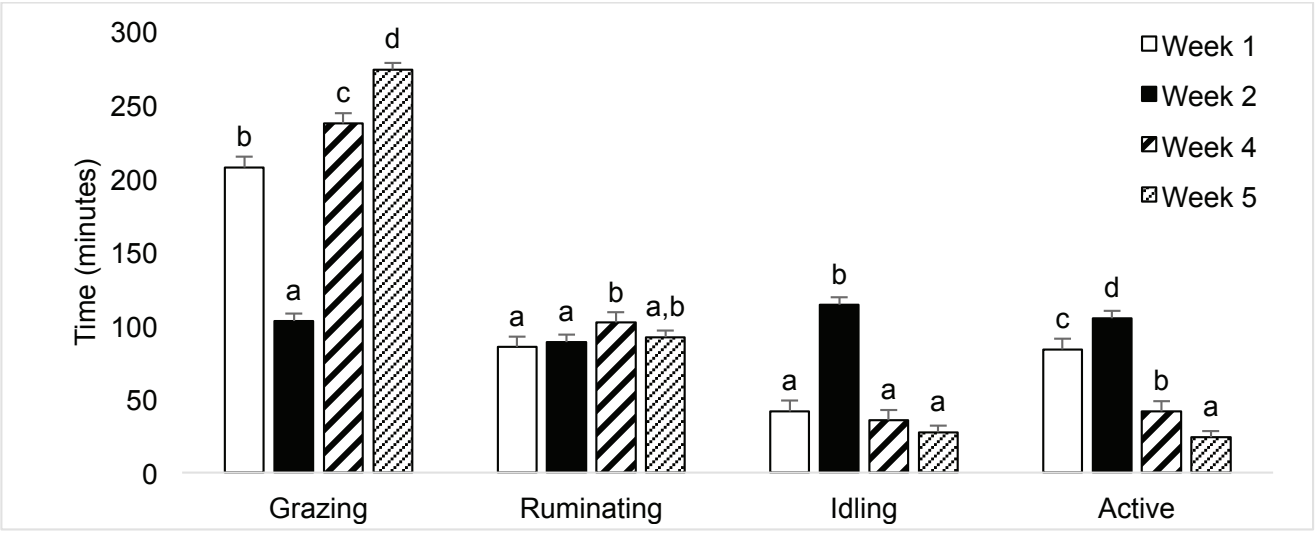
LA= low allowance; HA= high allowance; ADLIB= *ad libitum*.
[a,b]Means with different superscripts within each row are significantly different at P<0.05.

Figure 1(a) Mean time (+standard error bars) spent on each activity (grazing, ruminating, idling or active) within an eight-hour period one day after calves were given access to pasture. **(b)** Mean time (+standard error bars) spent on each activity by all calves within an eight-hour period each week.

(a)



(b)



LA = low allowance; HA = high allowance; ADLIB = *ad libitum* milk replacer
[a,b,c,d]values with different superscripts within each activity are significantly different at P<0.05.

from 198 calves (Groenendijk et al. 2018), ADLIB calves were heavier then LA and HA calves at 100 days of age. By week five of the current study, ADLIB calves were heavier ($P<0.05$) than LA and HA calves, though there was no difference in ADG among the treatments ($P>0.05$). Gut-fill may have affected these body weights, as LA calves were consuming more calf-starter than HA and ADLIB calves in the week after weaning (ADLIB=1.0±0.10 kg, HA=1.19±0.10 kg, LA=1.56±0.09 kg; $P<0.05$). This is also likely to have affected ADG over the study, as HA and ADLIB calves would have had less rumen fill than LA calves at the beginning and all calves would likely have had a high amount of rumen contents by the end of the study after having grazed pasture.

It was expected that LA calves would have better developed rumens at weaning due to greater pre-weaning calf-starter intake (Khan et al. 2011), and we speculated that they would spend more time grazing than the other calves. On the first observation day at 101 days of age, however, LA calves spent less time grazing than HA calves, but the same time as ADLIB ($P<0.05$; Figure 1a), while LA calves spent more time ruminating than HA and ADLIB calves ($P<0.05$). There was no difference in plasma β-hydroxybutyrate levels at 100 or 121 days of age ($P<0.05$; data not shown), which could indicate that there was no apparent difference in rumen development among treatments (Quigley et al. 1991). Pre-weaning calf-starter intake was inversely associated with milk-replacer intake (Groenendijk et al. 2018), and calf-starter intake remained greater in LA calves one week after weaning compared to HA and ADLIB calves ($P<0.05$). The LA calves might then have been less motivated to consume pasture due to a greater drive to eat calf starter, although there was no difference in calf-starter intake on the observation days, or over the following two weeks ($P>0.05$). Increased intake of solid feed leads to greater development of rumination (Khan et al. 2016), which may have led LA calves to spend more time ruminating and have less time to graze during the observation period.

In our study, it was apparent that calves had largely synchronous behaviour. Social interaction and learning is important in developing the foraging ability of young herbivores (Launchbaugh & Howery 2005), and calves have been shown to spend more time grazing and have greater pasture intake when housed in groups rather than individually (Phillips 2004). To accurately determine the impact of milk allowance on grazing and rumination time, it may therefore be necessary to keep animals from different treatment groups separate to avoid the effect of peer learning (Costa et al. 2016).

Excluding week 2, mean total grazing time by all calves increased each week, and was 274±7 minutes on the observation day of week 5, compared to 207±7 minutes in week 1 (Figure 1b). A possible explanation for this trend in grazing time is that in week 1, calves spent more time grazing because pasture was a new food source and they were being exploratory. By week 2, they were familiar with the diet and so grazing time was lower, but the declining pasture quality meant calves had to increase their grazing time to meet their nutrient requirements.

Pre-weaning milk allowance may affect the development of grazing and rumination behaviour of group-housed calves after weaning. This difference was expressed immediately after calves were given access to pasture but was lost within two weeks of grazing.

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