BRIEF COMMUNICATION: Do high-milk diets affect the growth rate of heifers prior to weaning?

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Introduction

Rearing replacement heifer calves is a labour-intensive and expensive component in the dairy system (Drackley 2008). Consequently, rearing systems need to produce well-grown animals that have good fertility and milk production and last many seasons in the herd. However, a large proportion of replacement heifers are not meeting target live weights in the New Zealand system (McNaughton & Lopdell, 2012) which has implications for future milk production, fertility and longevity in the herd (Van Amburgh & Tikofsky 2001). Although low cost, systems that result in small heifers may not be the most economic overall.

Optimal fertility and milk production in heifers is influenced to a great extent by growth prior to weaning (Holmes et al. 2003). This experiment is part of a larger project that examines the impact of liveweight gain of heifer calves fed different diets during the first year of life on subsequent milk production, fertility and longevity in the herd. The aim of the experiment presented here was to evaluate growth rates of heifer calves fed different volumes of milk, and therefore, different amounts of energy from milk in the pre-weaning period.

Materials and methods

This study was approved by the Massey University Ethics Committee and conducted from July – December 2014.

Experimental design

Sixty heifer calves were used in this experiment: 13 Holstein-Friesian (HF), 8 Jersey (J) and 39 J×HF (XB). All were born at No1 Dairy Farm, Massey University, Palmerston North, New Zealand, between July 21st and August 29th 2014. Calves were fed 2 L of milk twice daily until the Wednesday that they were 15-21 days old, at which time, differing feeding treatments were imposed. Calves were allocated to one of two treatment groups balanced for birth date, breed and liveweight breeding value.

Treatments were: (1) low milk feeding: 2 L of milk fed twice daily until calves were within 10 kg of weaning, and (2) high milk feeding: 3 L of milk fed twice daily for one week, then 4 L per feed twice daily until calves were within 10 kg of weaning. For both groups, once calves were within 10 kg of the target weaning live weight, they were fed 4 L once-daily in a single "pre-weaning" group until weaning. Weaning occurred when the calves reached a liveweight threshold of 100 kg for HF calves, 90 kg for XB calves or 80 kg for J calves.

Calves in both groups had *ad libitum* access to 20% crude protein (CP) meal (Supa 20, North Country Grains, Kaitaia, New Zealand) until they entered the pre-weaning group. Calves in the pre-weaning group had *ad libitum* access to 16% CP meal (Calfway 16, Denver Stock Feeds, Palmerston North, New Zealand).

Management and measurements

Calves were removed from dams daily at 0900 h, weighed and placed in the calf rearing shed. Calves were fed colostrum as described by Coleman et al. (2015). Due to the capacity of the shed, calves were moved from the shed to pasture at 2–3 weeks of age. Once at pasture, calves were moved every 2–3 days to ensure fresh pasture was always available. Calves were weighed every two weeks throughout the experiment, and were moved to the pre-weaning group, or weaned, on the first weighing day that they passed the threshold live weight.

Milk was fed at approximately 0800 and 1530 h daily. Calves fed once daily were fed at 0800 h only. Milk fed was colostrum from the first 8 milkings of each cow, stored in a plastic vat at room temperature and manually stirred twice daily prior to feeding, until it was used up. After this, milk fed to calves was whole milk taken from the milk supply vat.

Samples of calf milk were taken twice weekly from the vat of stored colostrum, and twice weekly from the milk removed from the milk supply vat for feeding to calves. Samples were stored at -20°C until analysed for fat % using the Mojonnier method (Atherton & Newlander, 1977) and crude protein % using the Dumas method (Ebeling, 1968). Metabolisable energy (ME) content of the milk was estimated using the following equation: ME (MJ/kg) = $(0.0376 \text{ fat} + 0.0209 \text{ CP} + 0.948)\times 0.95$ (McDonald et al. 2010).

Data handling and statistical methods

Milk energy consumed was calculated on a weekly basis using fat and protein content of the samples for that week, which was then summed over the total feeding period. Average daily liveweight gain from birth to weaning (ADG) was calculated as weaning weight less birth weight, divided by the number of days from birth to weaning.

Total milk energy consumed, ADG, weaning weight and days to weaning were analysed using a general linear model in SAS (version 9.3, SAS Institute Inc., Carey NC, USA) that included breed as a fixed effect and birth weight as a covariate.

Results

Calves in the high milk treatment consumed more milk (P<0.001) and ME from milk (P<0.001) than calves in the low milk treatment but there was no difference in ADG or weaning weight (Table 1). Calves in the high milk treatment achieved weaning target live weight 6 days earlier than calves in the low milk treatment (P<0.05).

Table 1 Least squares mean (±SEM) birth weight, weaning weight, average daily liveweight gain (ADG) from birth to weaning, metabolisable energy consumed from milk, and days to weaning of Friesian, Jersey and crossbred heifer calves fed a low or high milk allowance.

	Low	High	Significance
n	30	30	
Birth weight (kg)	30.4 ± 0.9	31.9 ± 0.9	NS
Weaning weight (kg)	95.6 ± 1.3	96.7 ± 1.3	NS
ADG (kg/day)	0.72 ± 0.02	0.78 ± 0.02	0.06
Milk consumed (L)	366 ± 10	531 ± 10	0.001
Total milk energy (MJ)	2198 ± 63	3269 ± 64	0.001
Days to weaning	90.6 ± 1.7	84.8 ± 1.8	0.05

Average daily liveweight gain and days to weaning were similar for HF and XB calves whereas ADG of J calves was lower, and J were weaned approximately seven days later than HF or XB calves (Table 2). This resulted in the milk and ME intake from milk being greater in J calves than HF or XB calves.

Table 2 Least squares mean (±SEM) birth weight, weaning weight, average daily liveweight gain (ADG) from birth to weaning, metabolisable energy consumed from milk, and days to weaning of Holstein Friesian (HF), Crossbred (XB) or Jersey (J) heifer calves.

	HF	XB	J	Significance
n	13	39	8	
Birth weight (kg)	37.5 ± 1.1[a]	30.2 ± 0.7[b]	24.5 ± 1.5[c]	0.001
Weaning weight	105.8 ± 1.6[a]	96.1 ± 0.9[b]	86.4 ± 2.0[c]	0.001
ADG (kg/day)	0.82 ± 0.02[a]	0.77 ± 0.01[a]	0.67 ± 0.03[b]	0.01
Milk consumed (L)	431 ± 13[a]	441 ± 7[ab]	475 ± 16[b]	0.1
Total milk energy (MJ)	2623 ± 77[a]	2675 ± 45[a]	2903 ± 100[b]	0.08
Days to weaning	84.1 ± 2.2[a]	85.8 ± 1.3[a]	93.1 ± 2.8[b]	0.05

[abc] Values within row without superscripts in common differ at the P<0.05 level.

Discussion

Feeding a greater amount of milk, and hence, milk energy had no effect on ADG or weaning weight of heifer calves in this experiment. The calves in the low milk treatment took slightly longer to reach weaning weight, which is in agreement with the results of Conneely et al. (2014). Industry target liveweight at 12 weeks of age (20% of mature live weight; McNaughton & Lopdell 2012) was reached by HF and XB but not by J calves. Mean weaning weight for each breed was approximately 6 kg above the planned weaning weight for this experiment, indicating that once calves were within 10 kg of planned weaning weight, frequency of weighing could have been increased to allow calves to be weaned earlier and closer to the planned weaning weight.

The similar growth rate between treatments was unexpected, and may be partially due to differences in consumption of meal. Meal consumption was not measured precisely in this experiment, but based on number of bags of meal fed, calves in the low milk treatment consumed more meal than those in the high milk treatment (approximately 24.1 kg/calf compared with 16.4 kg/calf, respectively). Greater consumption of meal has been reported in calves fed a restricted amount of milk, in order to supplement the lack of energy from low allowances of milk (Jasper & Weary 2002, Muir et al. 2002). Both groups of calves ate considerably less meal than expected, suggesting that calves were not sufficiently adapted to eating meal before being put out on pasture at a young age, and appeared to prefer pasture over meal in the present experiment. Meal intake was low when compared to restricted milk systems where weaning off milk can occur around 6 weeks of age when the calf is consuming 1 kg/day (Muir et al. 2002). However, the growth rate of calves over 12 weeks in this experiment was similar to that reported by Muir et al. (2002) when the restricted milk-fed calves were weaned off meal onto pasture.

These results indicate that feeding heifer calves 4 litres per day in two feeds is sufficient to meet their needs for growth when they are offered *ad libitum* meal and pasture as well, and that offering increased milk up to 8 litres per day decreases age at weaning slightly, but does not significantly affect ADG. Thus, the high-milk-feeding system incurred increased cost for little benefit in terms of pre-weaning growth.

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