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Interaction of gastro-intestinal nematodes and calf weaning management on beef cattle growth

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ABSTRACT

An experiment was undertaken to study the effects of calf weaning management on growth rates and susceptibility to gastro-intestinal nematodes. Treatments were: weaned at 6 months (of age) and normal anthelmintic use; weaned at 6 months and no anthelmintics; weaned at 6 months yet grazed with dam until 9 months and no anthelmintics; weaned at 9 months and no anthelmintics. At 9 months of age, calf live weights for the four treatments were: 264, 253, 265 and 308 kg respectively (SED = 2.0). Faecal-egg counts and serum pepsinogen levels were not affected by weaning date. Milk consumption by the later weaned calves was 4.2 kg/day, resulting in herbage intakes being 25% lower than calves in other treatments (P<0.01). When suckling calves to 9 months of age, the cost of this milk production to the cow was 26 kg live weight (SED = 6.3). Later weaning gave a substantial increase in calf live weight (P<0.001), which can be attributed to milk consumption. Faecal-egg counts and serum pepsinogen levels indicated that milk consumption did not have a direct effect on gastro-intestinal nematode burdens.

Keywords: beef cattle; weaning date; nematodes; *Cooperia*; milk intake; resilience.

INTRODUCTION

Concerns about the use of synthetic chemicals in food production systems have led to an expansion of 'natural and organic' markets. However, the withdrawal of anthelmintics from beef production systems leaves young cattle vulnerable to parasitism.

Beef calves are usually weaned between 5 to 7 months of age. Beef calves tend to display few signs of endoparasites before weaning, but become more vulnerable after weaning (Snyder, 1993). After weaning, calves are often placed in intensive finishing systems with high pasture larval (L3) contamination. This larval challenge, combined with reduced overall nutrition due to the loss of milk, weaning stress and increased herbage intake, may contribute to increased susceptibility to nematode infection. Furthermore, spring-born calves are usually weaned in autumn, when pasture quality and quantity is often low, fungal toxins high and L3 larval population on pasture is typically at its seasonal peak (Bisset & Marshall 1987).

McCall & Scott (1988) showed that calves weaned early (5 months of age) and then preferentially fed, did not grow as well as unweaned calves that were grazed with the cow on poorer quality pasture. It is suggested that this effect was largely due to the benefit of the milk consumed by the unweaned calves. Besides the nutritional benefits, milk consumption has also been shown to reduce parasite burdens in calves and lambs (Rohrbacher *et al.*, 1958; Ciordia *et al.*, 1985; Watson, 1991; Zeng *et al.*, 2001). Beef cow production of milk for suckling calves in late lactation can be variable depending on feeding level, age of cow and genetic factors (Robison *et al.*, 1978). Over recent years, the increased proportion of cows with dairy genetics in the New Zealand beef cow herd, has increased the potential for milk production in late lactation. Our proposition is that by delaying weaning of calves until 9 - 10 months of age, many of the issues that contribute to gastro-intestinal nematode infections may be avoided.

The study reported in this paper examined whether the effects of gastro-intestinal nematodes might be mitigated through delaying weaning within beef cow/calf systems, and if milk intake enhances calf resistance or resilience to parasitism.

METHODS

Treatments, animals and management

An experiment was undertaken at Whatawhata Research Centre on rolling to moderately steep hill land using 100 Friesian x Simmental calves that were generated through embryo transfer into Hereford x Friesian and Jersey cows. Calves were born between 21 August and 28 September 2000. Four treatments were established:

1. Early wean (6 months of age), anthelmintic-drench use (**EW/Dr**)
2. Early wean, no anthelmintic-drench (**EW/No Dr**)
3. No suckling after 6 months, but remain with cow until 9 months, no anthelmintic-drench (**No S/No Dr**)
4. Late wean (9 months of age), no anthelmintic-drench (**LW/No Dr**)

Treatments contained 25 calves (and cows in treatments 3 and 4) and were 'blocked' twice. Block 1 contained bull calves and block 2 contained heifer calves.

The experiment commenced at the time of early weaning (23 March 2001) when calves and cows were allocated to treatments. Treatments were balanced for calf live weight, faecal-egg count, serum pepsinogen level, date of birth and cow breed. The non-suckle treatment was imposed by the placement of udder covers on the cow, which remained in place until the time of late weaning.

The experimental treatments finished on 26 June 2001, when all cows were weighed and removed from the experimental area. Calves were then randomly allocated into two grazing groups within each block until 15 January 2002 to determine any 'carry over' treatment effects.

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Chemical use

All calves received vaccination for clostridial diseases (5 in 1) and vitamin B12 on 23 March; vitamin B12 and an oral copper oxide capsule on 15 May; and a pour-on ectoparasiticide (for lice control) on 24 July 2001.

No anthelmintic drench was given to the calves prior to the commencement of the experiment. All calves within the **EW/Dr** treatment were treated with levamisole at the time of early weaning, followed by endectocide on 24 April and levamisole on 12 June. A combination drench of levamisole and endectocide was given on 16 July and 13 September. If individual calves within the 'no drench' treatments showed a high faecal-egg count (FEC, >600 epg.) or elevated serum pepsinogen level (>3.0 mU/l), they were salvage drenched with levamisole to minimize suffering and loss.

Pasture management and measurement

Six-month-old dairy-beef calves were grazed on the pastures prior to the commencement of this experiment. Their drenching programme was delayed to ensure endoparasite contamination of the trial site.

The grazing of treatments was managed in such a way that they experienced similar pre- and post-grazing pasture levels. During the main experiment (23 March - 26 June), both early wean treatments were grazed together within each block. Grazing durations ranged from 2 - 5 days per paddock. Treatments were not confined to distinct land areas and grazing sequences ensured that calves in all treatments were exposed to similar levels of L3 contamination.

Pre- and post-grazing herbage mass was assessed on alternate weeks and samples were collected to determine the levels of metabolisable energy (NIRS technique), and for L3 identification and enumeration.

Cattle measurements

Cows and calves were weighed every two weeks throughout the study. All weights were collected after cattle had been *ad lib.* fed for the previous 24 hours. All calves were faecal and blood sampled four times during the study, *viz.*: 20 March (early weaning), 1 May, 26 June (late weaning) and 4 September. These faecal and blood samples were analysed for FEC and pepsinogen concentration respectively. Bloods collected on 1 May were also assayed for gamma-glutamyltransferase (GGT) concentration. A larval culture was undertaken on faecal samples that had faecal-egg concentrations >100 eggs/gram, to determine the species composition of calf worm burdens.

Milk intake of calves in the **LW/No Dr** treatment was assessed three times during the experiment using a 'calf suckling' technique. Calves and cows were separated overnight, allowed to suckle, separated again for 8 hours and then weighed, suckled and reweighed. For the first two assessments, data was extrapolated to estimate 24-hour milk consumption. The 20 June assessment was over a full 24 hour period. On 27 June, a milk sample was collected by fully milking out (with the use of Oxytocin) one udder quarter from six Jersey and six Hereford x Friesian cows. These samples were analysed for milk components.

Calf herbage intakes were measured in April and June through the use of n-alkanes (Dove & Mayes, 1991). Slow-release alkane capsules were administered to six calves from each treatment within each replicate. Faecal and pasture samples were collected between 8 - 15 and 17 - 23 days post-administration. These were analysed for C31, C32 and C33 alkane concentrations. C31 and C33 alkane concentrations were averaged when herbage intake calculations were undertaken.

During early April and again in late June, cattle from **No S/No Dr** and **LW/ No Dr** treatments were observed during all daylight hours over 2 days. Distance between all calf and cow pairs and the calf to the median located cow in the herd, were measured hourly. Timing and duration of suckling within the **LW/No Dr** treatment was recorded.

Statistical and energy balance analyses

All treatment effects were analysed using analysis of variance (GenStat 6.1). Subsequent live weights were adjusted using starting live weight as a covariate. FECs were log transformed prior to analysis.

The energy consumed by calves was calculated using the estimates of pasture intake, milk intake and milk composition. The energy contained in the milk was adjusted for the greater efficiency of gain that milk provides (Holmes et al., 1987). The consumed energy was then compared with that required to achieve the measured liveweight gain.

RESULTS

Live weights and liveweight gains

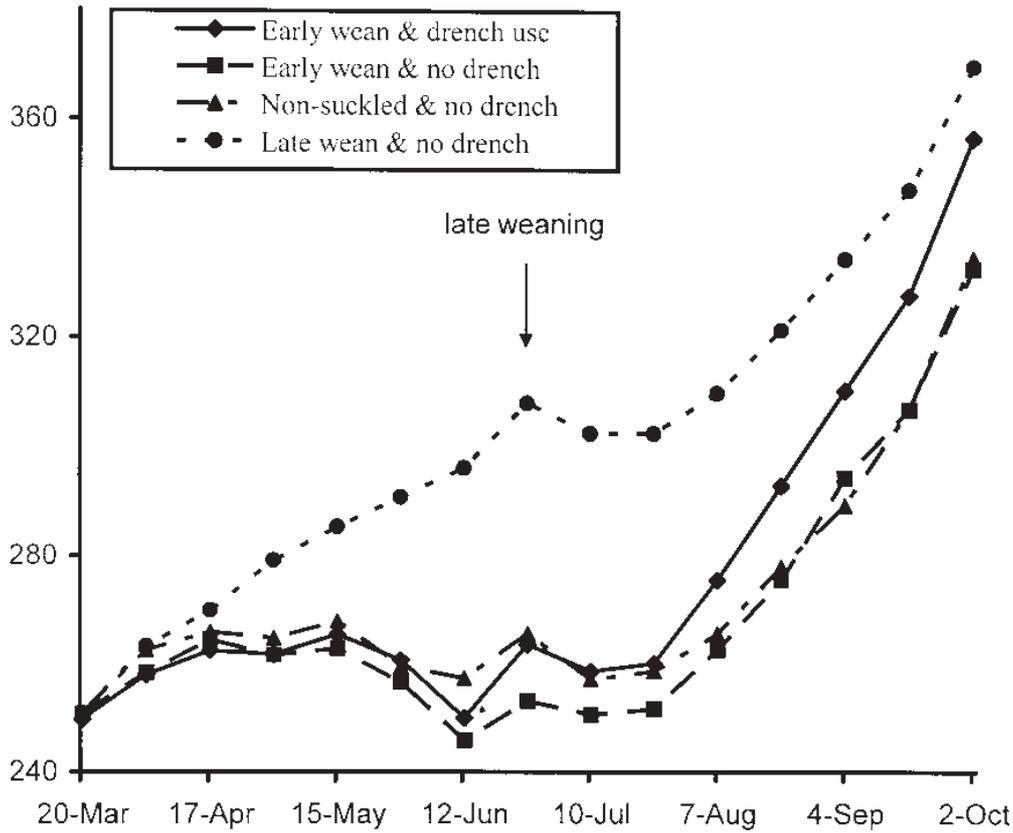
The liveweight change pattern is shown in Figure 1. During the treatment period (23/3 - 26/6) the **LW/No Dr** calves grew faster ($P<0.001$) and the **EW/No Dr** calves slower ($P<0.01$) than the other treatments (Table 1). During the carry-over period (26/6/01 - 15/1/02) **EW/Dr** calves had the highest and **LW/No Dr** calves the lowest

TABLE 1: Calf live weights (LW, kg), calf liveweight gain/day (LWG, kg) and cow liveweight gain/day during the treatment period and the 'carry over' period, and calf herbage intakes (kg DM/head/day).

	Calf LW	Calf LW	Calf LW	Calf LWG	Calf LWG	Cow LWG	April Intake	June Intake
	26/6/01	2/10/01	15/1/02	23/3-26/6	26/6-15/1	23/3-26/6		
Early wean & drench use	264 ^a	360 ^a	467 ^a	0.15 ^a	1.00 ^a		4.63 ^a	4.33 ^a
Early wean & no drench	253 ^b	333 ^b	443 ^b	0.03 ^b	0.93 ^b		4.30 ^a	4.17 ^a
Non-suckled & no drench	265 ^a	335 ^b	448 ^b	0.15 ^a	0.90 ^b	0.14 ^b	4.15 ^a	4.05 ^a
Late wean & no drench	308 ^c	372 ^a	482 ^a	0.60 ^c	0.86 ^c	-0.13 ^a	3.16 ^b	3.33 ^b
SED	2.8	5.6	6.3	0.03	0.02	0.07	0.32	0.27

Values within columns with different superscripts are significantly different by analysis of variance ($P<0.05$).

FIGURE 1. Mean calf live weights (kg) during the treatment and first portion of the carryover period.



liveweight gains. Despite this, **LW/No Dr** calves were still heavier ($P<0.01$) than all other treatments at the end of the study (15/1/02). There were no interactions between sex of calf and treatment, although bull calves grew significantly faster than heifers during the ‘carry over’ period. At the time of late weaning, adjusted cow live weights were 26 kg higher in the **No S/No Dr** than the **LW/No Dr** treatment. Breed of cow did not influence calf growth rate.

Pasture conditions, herbage and milk intakes

Pasture conditions did not differ between treatments. During the treatment period, mean pre- and post-grazing mass was 2893 and 1496 kg DM/ha respectively. Mean herbage metabolisable energy concentration was 9.6 MJ ME/kg DM.

Herbage intakes of the **LW/No Dr** calves were 29% ($P<0.001$) and 21% ($P<0.01$) lower than the mean of the other treatments during April and June respectively (Table 1). There were no significant differences between the other treatments. The heifer calves had intakes 27% ($P<0.001$) and 15% ($P<0.01$) lower than the bull calves in April and June respectively.

All calves within the **LW/No Dr** treatment were observed to be suckling at each assessment during the treatment period. Mean calf milk intakes (kg/head/day) were 5.0 (± 0.9) on 10 April, 4.2 (± 1.7) on 31 May and 3.2 (± 1.3) on 20 June. Milk fat and total milk solids on 27 June were 5.2% (± 1.8) and 14.5% (± 1.6) respectively. Differences in milk production between cow breeds were

not significant, however, Jersey cows tended to produce a lower quantity of milk with a higher concentration.

Table 2 displays the balance between energy consumed and energy required for the measured liveweight change in the **No S/No Dr** and **LW/No Dr** treatments.

Parasitology

Mean L3 concentrations on pasture were below 500/kg fresh herbage throughout the study, except for a spike of up to 1900/kg herbage between 20 June and 18 July. *Cooperia* spp. (principally *C. oncophora*) made up 79% of the larvae on pasture, 14% *Ostertagia* spp., 4% *Trichostrongylus* spp. and 3% others. There were no significant differences between treatments.

Faecal-egg counts and serum pepsinogen levels (Table 3) showed no consistent pattern of treatment differences. The number of calves requiring salvage drenching was 6, 4 and 1 for the **EW/No Dr**, **No S/No Dr** and **LW/No Dr** treatments respectively. Larval cultures showed that the faecal-egg output comprised 90% *Cooperia* spp., 8%

TABLE 2: Assessment of calf energy intakes based on measured pasture and milk intakes (adjusted for efficiency of gain), and assessment of energy required (MJ ME/head/day) for live-weight gain during the treatment period.

	ME consumed	ME required
Bull calves, non-suckled	43	42
Bull calves, late wean	57	61
Heifer calves, non-suckled	37	40
Heifer calves, late wean	51	58

TABLE 3: Mean calf faecal-nematode-egg counts (FEC, eggs/g), calf serum pepsinogen levels (Pep, mU/l) and gamma-glutamyltransferase levels (GGT, IU/l).

	FEC 1 May	FEC 26 Jun	FEC 4 Sep	Pep 1 May	Pep 26 Jun	Pep 4 Sep	GGT 1 May
Early wean & drench use	19	14	19	0.91	1.55	1.40**	15
Early wean & no drench	22	35	21	0.92	1.61	1.81	22
Non-suckled & no drench	16	97**	31	0.99	1.45	1.81	19
Late wean & no drench	11	31	19	0.89	1.36	1.94	15
SED	8.3	16.8	11.3	0.09	0.13	0.14	14.4

** indicates data significantly different to other treatments ($P < 0.01$)

Trichostrongylus spp. and 2% *Ostertagia* spp. Serum pepsinogen levels increased as the study progressed. GGT levels were low and had no treatment differences, indicating no effect of facial eczema.

Behaviour observations

On average, **LW/No Dr** calves suckled 2.3 (± 0.34) and 1.6 (± 0.38) times/day during the daylight hours in April and June respectively. The average duration of suckling was similar between the April and June observation times, being 10.4 (± 0.94) and 10.1 (± 0.81) minutes respectively. Calf and cow association, in terms of distance apart in the paddock, was not different between **LW/No Dr** and **No S/No Dr** treatments. Mean distances (metres) between calf to dam, and the same calf to the average cow in the herd, were 15.0 (± 0.8) and 21.9 (± 1.0) respectively.

DISCUSSION

Calf growth rates were low during the treatment period for all but **LW/No Dr** calves. This was surprising given pasture conditions during that period. It is likely that internal parasites were limiting calf growth rates. Anthelmintic treatment to the **EW/Dr** calves resulted in a small liveweight gain advantage during the treatment period. This treatment may have been compromised by the use of an endectocide anthelmintic during late autumn, which did not adequately control *Cooperia oncophora*, the main endoparasite species present.

For the **No S/No Dr** calves, grazing in the company of their dams provided little advantage over the **EW/No Dr** treatment, despite the behaviour observations demonstrating little change to the cow/calf associations. The superior growth rates of the **LW/No Dr** calves, demonstrates the beneficial effects of milk intake on calf growth rate. This substantial advantage has been observed in other studies (McCall & Scott, 1988; Ciordia *et al.*, 1985). Most of this advantage was maintained during the 'carry over' period. It should be noted that the higher comparative weight gains of the **EW/Dr** calves during the 'carry over' period, indicates that parasitism was compromising liveweight gains of the other three non-drench treatments during this period. Milk production between 6 and 9 months post calving, cost the **LW/No Dr** cows 26 kg live weight. The significance of this cost on cow production during the subsequent season, would depend on cow condition and the availability of feed during winter and spring.

L3 levels on pasture were low compared to those reported by Bisset & Marshall (1987). Calf FECs were

also low despite most calves never receiving any anthelmintic drench, which may in part reflect the low pasture L3 levels. The increase in serum pepsinogen levels as the study progressed, probably indicates the increase of *Ostertagia* and *Trichostrongylus* challenge to the calves. **LW/No Dr** calves had FEC and pepsinogen levels similar to the other non-anthelmintic treatment calves, indicating that milk did not have a significant effect on the establishment of worm burdens.

The extra energy calves received through milk consumption combined with the enhanced efficiency of gain that milk energy provides, explained the majority of the greater performance within the **LW/No Dr** treatment. Any further advantage of the **LW/No Dr** calves may be due to improved protein nutrition from milk, enhancing calf resilience against the effects of parasite challenge (Van Houtert & Sykes, 1996).

Application

The calf liveweight advantage resulting from later weaning was substantial within this context of no anthelmintic use. Most of this advantage remained until the end of the study. Delaying weaning beyond the normal 5 – 7 months of age seems a good option for farmers to reduce the effects of gastro-intestinal parasites within low-chemical production systems.

The study also raises the question of most appropriate weaning date in the wider beef industry. However, some factors need to be considered. This study clearly showed that the effect was almost totally a response to milk intake by the calf. In this study, pasture feeding levels are likely to have been better than what many breeding cows in New Zealand are subjected to in late autumn and early winter. Poorer nutrition may reduce milk production of cows, especially within pure beef breeds, and any calf liveweight advantage may be lessened. Farmers with entire bull calves would also need to consider the risk of heifer calves being mated by siblings. On the other hand, the response to late weaning may be greater if calves are less well grown and/or under a higher parasite challenge.

The cost in terms of cow live weight was also quantified within this study. The authors consider that this is a feed allocation issue that can be managed, rather than be seen as a cost. The real cost may come in the inability to clean up poor-quality pasture to the same degree as with weaned cows. Investigation of the effect of cow nutrition on late-weaned calves would clarify this issue.

Delaying weaning from 6 months of age to 9 months of age provided a 55 kg advantage in calf live weight. Milk intake was the main driver of this advantage. Milk

intake during late lactation did not provide any significant protection against nematode infection. These findings need to be tested in various commercial contexts before broad industry recommendations can be made.

ACKNOWLEDGEMENTS

Appreciation extended to Shane Hill, Alf Richards, Paul Stensness, Margaret Scott and Anna Brooky (AgResearch Whatawhata) for assistance with the field research; the mentor farmer group, Andrew Fisher and Eric Kolver for advice, Duncan Smeaton for the energy intake and requirement comparison and Catherine Cameron for statistical analyses. This study was undertaken with funding from the Foundation for Research, Science and Technology.

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