Journal of Dairy Research (2006) **73** 273–276. © *Proprietors of Journal of Dairy Research 2006* 273
doi:10.1017/S0022029906001816 *Printed in the United Kingdom*

Dry matter intake precalving in cows offered fresh and conserved pasture

John R Roche*

Dexcel, Private Bag 3221, Hamilton, New Zealand

Received 18 August 2005 and accepted for publication 10 October 2005

Keywords: Transition cow, pasture, dry matter intake.

Maintaining dry matter intake (DMI) during the last 2 weeks of gestation is difficult, and a failure to do so is reported to have negative implications on postcalving DMI (Grummer, 1995) and subsequent milk production (Bertics et al. 1992). DMI at the end of gestation, but excluding the last 1–2 d before parturition, can decrease by up to 30% (Lodge et al. 1975; Bertics et al. 1992; Dewhurst et al. 2000). The extent of the decline varies and may be influenced by a number of factors, such as level of feeding precalving (Lodge et al. 1975; Murphy, 1999; Dewhurst et al. 2000) or amount of non-structural carbohydrates in the precalving diet (Coppock et al. 1972; Forbes, 1995). Most studies were undertaken with cows receiving total mixed ration (TMR) or conserved forage and concentrates. However, this may have been one of the reasons for the witnessed depression. Increasing the proportion of rapidly fermentable carbohydrates or alternatively decreasing the fibre concentration in the precalving diet appears to exacerbate this decline (Coppock et al. 1972; Minor et al. 1998). Research suggests that ruminants may actively select against concentrates as plasma oestrogen concentrations increase, such as happens in the weeks preceding parturition (Forbes, 1995). When hay was offered *ad libitum*, increasing concentrations of oestrogen (up to 400 μg infused intravenously) had no effect. However, when a complete pelleted diet was offered, a 90-μg infusion caused a lower feed intake, followed by a significant increase after treatment was stopped. The lack of depression in precalving DMI reported by Coppock et al. (1972) and Vazquez-Anon et al. (1994) when forage was the principal component of the diet, supports this. Little information is available on the precalving decline in DMI when dairy cows are fed a diet of fresh and conserved pasture.

Methods

Treatments

Data from two independent experiments (Roche et al. 2003a, b) investigating the effect of precalving dietary cation-anion difference (DCAD) on Ca homeostasis and milk production, and undertaken in different years were used to study the decline in DMI prior to calving. In both years cows were individually fed in confinement for the duration of the experiment. In Experiment 1 (1997; Roche et al. 2003a), 14 multiparous (mean ± SD; 6 ± 2·5 years old) Holstein-Friesian cows (649 ± 71·4 kg) were offered a daily diet of 5 kg DM of predominantly perennial ryegrass-dominant (*Lolium perenne* L.) pasture-hay in the morning and 5 kg DM of freshly cut pasture in the afternoon for 19 ± 5 d precalving. Four DCAD treatments were imposed by orally supplementing cows with predefined mixtures of mineral compounds. After calving, the cows were switched to a ration of 6 kg DM of crushed barley (gradually over 3 d, increasing by 2 kg/d) and freshly cut pasture *ad libitum*. In Experiment 2 (1998; Roche et al. 2003b), 36 multiparous (5 ± 3 years old) Holstein-Friesian cows (604 ± 42·4 kg) were offered a daily diet of 5 kg DM of pasture-hay in the morning and freshly cut pasture *ad libitum* in the afternoon for 17 ± 7 d before calving. Two precalving DCAD treatments were investigated. After calving, the cows were switched to a ration of 6 kg DM of barley (gradually over 3 d) and pasture-hay *ad libitum*. In both experiments, *ad libitum* was defined as 110% of the amount eaten on the previous day.

Measurements

Milk yields of individual cows were recorded daily (Alfa Laval Alpro milk meter system, Tumba, Sweden) and pm and am milk samples were collected from individual cows on two days each week for 14 d postcalving. Fat, protein and lactose concentrations of milk were determined by Milkoscan (Foss Electric, Hillerød, Denmark). Cow body weight (BW) was recorded on two consecutive days before treatment allocation and an average used. Pre-experiment BW was not available for two cows in Experiment 1 and four cows in Experiment 2 and their data were therefore omitted.

Feed offered and refusals were weighed and representative samples of each feed offered and refused were dried at 105 °C to constant weight to determine DMI of

*For correspondence; e-mail: john.roche@dexcel.co.nz

Table 1. Mean dry matter (DM, %), crude protein (CP, % DM), dry matter digestibility (DMD, % DM) metabolizable energy (ME) content (MJ/kg DM) and macromineral content (% DM) of the pasture and hay offered precalving and the barley offered postcalving in both years under investigation

	DM	CP	DMD	ME	K	Na	Cl	S	Mg	Ca	P
1997											
Pasture	16·2	20·3	80	11·6	3·37	0·35	1·21	0·28	0·23	0·41	0·35
Hay	82·5	7·2	60	8·2	1·64	0·55	1·84	0·17	0·23	0·28	0·16
1998											
Pasture	16·5	24·3	76·3	11·0	3·4	0·33	1·14	0·30	0·25	0·43	0·39
Hay	87·4	13·8	70·4	10·0	2·8	0·33	0·82	0·16	0·24	0·77	0·19
1997											
Barley	89·0	12·7	79	11·4	0·49	0·11	0·18	0·11	0·12	0·04	0·26
1998											
Barley	80·0	10·9	75·7	13·3	0·6	0·06	0·24	0·13	0·85	0·36	0·27

individual cows. Samples of all feeds were bulked on a weekly basis and dried at 65 °C for 72 h, ground to pass through a 0·5 mm sieve (Christy Lab Mill, Suffolk, UK) and analysed for dry matter digestibility *in vitro* (DMD), nitrogen and macrominerals. DMD was determined by the method of Clarke et al. (1982). Metabolizable energy (ME, MJ/kg DM) was calculated from DMD: $ME=(DMD*0{\cdot}17)-2$; (Standing Committee on Agriculture, 1990). Nitrogen content was determined by a Kjeldahl method using Buchi Kjeldahl nitrogen apparatus, with crude protein (CP) being calculated from nitrogen ($CP=N*6{\cdot}25$). Macrominerals were determined using x-ray spectroscopy (Hutton & Norrish, 1977; Norrish & Hutton, 1977). Nutrient composition of feeds offered is presented in Table 1.

Calculations and Statistical Analysis

Treatments within years did not affect DMI. Mean DMI and rate of change (increase or decrease) of DMI precalving (day −14 to −3) and postcalving (day 5 to 14) were calculated for each cow. The rate of change (slope) was calculated using regression. Analysis of variance was used to estimate differences between the 1997 and 1998 herds for these rates and means, and differences between successive days. Relationships between precalving DMI (mean of day −14 to −3), and postcalving measurements (mean DMI for days 10–14; milk data mean for days 5–14) were investigated using regression analysis (Genstat V, 1997). The relationship between DMI on day −2 and day −1, and day 0 relative to calving and postcalving DMI was also determined.

Results and Discussion

Results comparing years must be treated with caution. However, although consolidating data from two different years is not ideal, between-year variation was minimized. All animals were individually fed similar diets (Table 1) precalving and housed in the same animal housing facility in both years.

The diets offered were different from those previously investigated. Most previous studies examined precalving DMI in cows offered either TMR or forages and concentrates. The effect of periparturient hormonal changes on a cow's selective preference for forages and concentrates (Forbes, 1995) may have been one factor influencing the precalving decline (Stockdale & Roche, 2002). In contrast, in the current study cows received 100% forage diets until the day of calving.

Precalving and postcalving DMI and the slope of the change in DMI are presented in Table 2 and Fig. 1. Cows consumed $8{\cdot}8\pm1{\cdot}25$ and $10{\cdot}1\pm1{\cdot}17$ kg DM/d precalving in 1997 and 1998, respectively, and had a postcalving DMI of $13{\cdot}4\pm2{\cdot}31$ and $14{\cdot}6\pm2{\cdot}16$ kg DM/d. DMI as a % BW was $1{\cdot}35\pm0{\cdot}24$% and $1{\cdot}67\pm0{\cdot}23$% precalving, and $2{\cdot}04\pm0{\cdot}35$% and $2{\cdot}43\pm0{\cdot}33$% postcalving in 1997 and 1998, respectively. Mean precalving energy intakes were 87 and 103 MJ/cow per day for 1997 and 1998, respectively, or approximately 75 and 95% of predicted energy requirements respectively (Roche et al. 2005).

Previous studies of precalving DMI have recounted variable findings, with reports of large (~20%; Bertics et al. 1992; Van Saun et al. 1993; Dann et al. 1999; Murphy, 1999; Dewhurst et al. 2000) and small or negligible (Vazquez-anon et al. 1994; Dewhurst et al. 1996; Wu et al. 1997; Minor et al. 1998; Huyler et al. 1999; Agenas et al. 2003) declines in DMI prior to calving. In the present work, excluding the final two days precalving, no depression in DMI was evident in the 14 d prior to calving, either in cows offered restricted or *ad libitum* access to pasture and pasture hay (Fig. 1). The slopes of the change in DMI prior to day −2 precalving were −0·03 and 0·05 kg DM/cow per day for 1997 and 1998, respectively, and these were not significantly different from zero ($P>0{\cdot}1$).

A number of reasons have been suggested to account for the *prepartum* DMI decline. However, the reasons for the inconsistent findings remain unclear. In their review Stockdale & Roche (2002) hypothesized that differences in precalving level of feeding might be one reason for the variation in the extent and duration of the decline in DMI in the weeks preceding calving. This hypothesis is

Table 2. Daily precalving and postcalving dry matter intake (DMI) and slope of DMI change in cows consuming approximately 75% (1997) or 95% (1998) of predicted precalving energy requirements as fresh and conserved pasture and offered 6 kg DM crushed barley and forage *ad libitum* postcalving

	1997	1998	SED	*P*
Precalving				
DMI, kg DM	8·8	10·1	0·37	<0·001
DMI, % BW†	1·35	1·67	0·072	<0·001
Slope, kg DM/d	−0·03	0·05	0·075	0·28
Postcalving				
DMI, kg DM	13·4	14·6	0·68	0·09
DMI, % BW†	2·04	2·43	0·105	<0·001
Slope, kg DM/d	0·38	0·31	0·089	0·41

† BW = Pre-experimental bodyweight

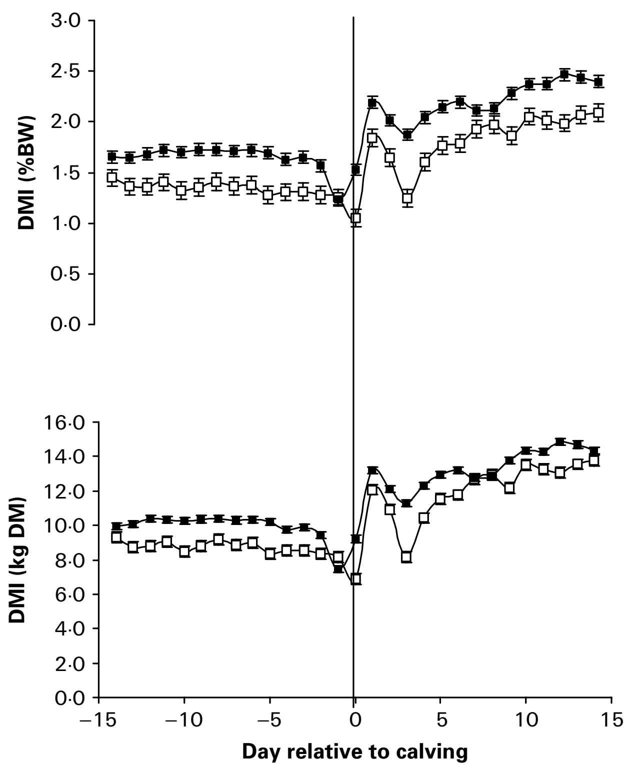

Fig. 1. Precalving and postcalving dry matter intake (DMI) of cows consuming approximately 75% (1997; □) or 95% (1998; ■) of predicted precalving energy requirements as fresh and conserved pasture and offered 6 kg DM crushed barley and forage *ad libitum* postcalving.

supported by earlier reports (Lodge et al. 1975; Murphy, 1999; McNamara et al. 2003) showing greater depressions in precalving DMI in well-fed cows compared with those offered a restricted allowance. However, this is not consistent with the present findings, where there was no decline in DMI until 2 d precalving irrespective of intake, and the subsequent reduction in DMI was not different in 1997 or 1998. Coppock et al. (1972) reported a decline in DMI when concentrates were included in the diet, potentially because of the effects of rising plasma oestrogen concentrations on preferential diet selection (Forbes, 1995). It is plausible that the lack of a decline in DMI in the present studies was due to the lack of concentrates in the diet in both years. It is not possible to say whether this is the only reason for the lack of effect, but in the two years where pasture and hay were fed to dairy cows as the sole diet, there was no depression in DMI until 2 d precalving. Nevertheless, although there was no evidence of an effect of feeding level on the extent of the decline in DMI prior to day −2 relative to calving in the present results, the extent of the decline in DMI in the final 2 d before calving remains important because a positive, albeit weak, relationship ($P<0·05$; $r^2=0·1$) between DMI on the day of calving and mean DMI postcalving was evident (Table 3).

Table 3. Correlations† (r^2) between precalving dry matter intake (DMI) during days −14 to −3, days −2 to −1 and day 0 relative to calving and postcalving DMI (days 10–14 post-calving) and milk production traits

	Precalving DMI, kg DM/cow per day		
Trait	Day −14 to −3	Day −2 to −1	Day 0
Postcalving DMI, kg/d	0·00	0·08*	0·10*
Milk yield, kg/d	0·04	0·01	0·00
FCM, kg/d	0·03	0·02	0·00
Fat content, g/100 g	0·04	0·01	0·00
Protein content, g/100 g	0·15**	0·00	0·00
Lactose content, g/100 g	0·01	0·00	0·00
		% BW‡	
Postcalving DMI, kg/d	0·01	0·04	0·08*
Milk yield, kg/d	0·12**	0·00	0·00
FCM, kg/d	0·08*	0·00	0·00
Fat content, g/100 g	0·03	0·01	0·00
Protein content, g/100 g	0·13**	0·00	0·00
Lactose content, g/100 g	0·03	0·00	0·00

† *$P<0·05$, **$P<0·01$
‡ Pre-experimental body weight

The relationship between precalving DMI and milk production reported in the literature is also unclear. Bertics et al. (1992) reported a positive relationship between precalving DMI and fat-corrected milk (FCM). On average, cows in the experiments reported here produced 28·9 ± 5·08 kg FCM (29·3 ± 5·35 and 28·6 ± 4·89 kg in 1997 and 1998, respectively) but there was no relationship between milk yield or FCM yield and precalving DMI, when DMI was measured as kg DM, and only a weak negative ($P<0·05$; $r^2=0·12$ and 0·08, respectively; slope = −4·4 and −3·7, respectively) relationship when DMI was expressed as a % BW. This lack of effect of precalving DMI on milk production is consistent with recent research (Douglas et al. 1998; Holcomb et al. 2001; Agenas et al. 2003; Roche et al. 2005) all reporting

https://doi.org/10.1017/S0022029906001816 Published online by Cambridge University Press

little if any effect of precalving DMI on subsequent milk production. There was a small ($P<0\cdot01$; $r^2=0\cdot15$ and $0\cdot13$, respectively; slope$=0\cdot07$ and $0\cdot35$ for DMI expressed as kg DM and % BW, respectively) positive effect of precalving DMI on milk protein content in the current study.

This study showed no evidence of a decline in DMI prior to day −2 relative to calving when cows were offered a diet of fresh pasture and pasture hay. A weak, but positive relationship between DMI on the day of calving and postcalving DMI was found, but there was little effect of precalving DMI on milk production.

The author acknowledges the statistical expertise of B Dow, the technical assistance of P Durling, G Lineham and K Baum, and all the help afforded by farm staff.

References

Agenas S, Burstedt E & Holtenius K 2003 Effects of feeding intensity during the dry period. 1. Feed intake, body weight, and milk production. *Journal of Dairy Science* **86** 870–882

Bertics SJ, Grummer RR, Cadorniga-Valino C & Stoddard EE 1992 Effect of prepartum dry matter intake on liver triglyceride concentration and early lactation. *Journal of Dairy Science* **75** 1914–1922

Coppock CE, Noller CH, Wolfe SA, Callahan CJ & Baker JS 1972 Effect of forage-concentrate ratio in complete feeds fed *ad libitum* on feed intake *prepartum* and the occurrence of abomasal displacement in dairy cows. *Journal of Dairy Science* **55** 783–789

Dann HM, Varga GA & Putnam DE 1999 Improving energy supply to late gestation and early postpartum dairy cows. *Journal of Dairy Science* **82** 1765–1778

Dewhurst RJ, Davies DWR, Fisher WJ & Aston K 1996 Effect of undegradable protein given for 6 weeks before calving on the performance of dairy cows in the subsequent lactation. *Animal Science* **62** (Suppl. 1) 643

Dewhurst RJ, Moorby JM, Dhanoa MS, Evans RT & Fisher WJ 2000 Effects of altering energy and protein supply to dairy cows during the dry period. 1. Intake, body condition, and milk production. *Journal of Dairy Science* **83** 1782–1794

Douglas GN, Drackley JK, Overton TR & Bateman HG 1998 Lipid metabolism and production by Holstein cows fed control or high fat diets at restricted or ad libitum intakes during the dry period. *Journal of Dairy Science* **81** (Suppl. 1) 295

Forbes JM 1995 *Voluntary Food Intake and Diet Selection in Farm Animals. 1st Edition.* Bristol, UK: CAB International

Genstat V Committee 1997 Genstat 5, Release 4.1. Reference Manual. Oxford, UK: Oxford University Press

Grummer RR 1995 Impact of changes in organic nutrient metabolism on feeding the transition dairy cow. *Journal of Animal Science* **73** 2820–2833

Holcomb CS, Van Horn HH, Head HH, Hall MB & Wilcox CJ 2001 Effects of *prepartum* dry matter intake and forage percentage on *postpartum* performance of lactating dairy cows. *Journal of Dairy Science* **84** 2051–2058

Hutton JT & Norrish K 1977 Plant analyses by x-ray spectrometry. 2. Elements of atomic number greater than 20. *X-Ray Spectrometry* **6** 12–17

Huyler MT, Kincaid RL & Dostal DF 1999 Metabolic and yield responses of multiparous Holstein cows to prepartum rumen-undegradable protein. *Journal of Dairy Science* **82** 527–536

Lodge GA, Fisher LJ & Lessard JR 1975 Influence of prepartum feed intake on performance of cows fed ad libitum during lactation. *Journal of Dairy Science* **58** 696–702

McNamara S, O'Mara FP, Rath M & Murphy JJ 2003 Effects of different transition diets on dry matter intake, milk production, and milk composition in dairy cows. *Journal of Dairy Science* **86** 2397–2408

Minor DJ, Trower SL, Strang BD, Shaver RD & Grummer RR 1998 Effects of nonfiber carbohydrate and niacin on periparturient metabolic status and lactation of dairy cows. *Journal of Dairy Science* **81** 189–200

Murphy JJ 1999 Effect of dry period protein feeding on post-partum milk production and composition. *Livestock Production Science* **57** 169–179

Norrish K & Hutton JT 1977 Plant analyses by x-ray spectrometry. 1. Low atomic number elements, sodium to calcium. *X-Ray Spectrometry* **6** 6–11

Putnam DE, Soder KJ, Holden LA, Varga GA & Dann HM 1997 Periparturient traits correlate with *postpartum* dry matter intake and milk yield. *Journal of Dairy Science* **80** (Suppl. 1) 142

Roche JR, Dalley DE, Moate PJ, Grainger C, Rath M & O'Mara F 2003a Dietary Cation-Anion Difference and the health and production of pasture-fed dairy cows. 2. Non-lactating periparturient cows. *Journal of Dairy Science* **86** 979–987

Roche JR, Dalley DE, Moate PJ, Grainger C, Rath M & O'Mara F 2003b A low dietary cation-anion difference precalving and calcium supplementation postcalving increase plasma calcium but not milk production in a pasture-based system. *Journal of Dairy Science* **86** 2658–2666

Roche JR, Kolver ES & Kay JK 2005 Influence of precalving feed allowance on periparturient metabolic and hormonal responses and milk production in grazing dairy cows. *Journal of Dairy Science* **88** 677–689

Standing Committee on Agriculture (SCA) 1990 Feeding Standards for Australian Livestock-Ruminants. In: *Ruminants*. (Eds Ruminants Subcommittee) Melbourne: CSIRO Publications

Stockdale CR & Roche JR 2002 A review of the energy and protein nutrition of dairy cows through their dry period and its impact on early lactation performance. *Australian Journal of Agricultural Research* **53** 737–753

Van Saun RJ, Idleman SC & Sniffen CJ 1993 Effects of undegradable protein amount fed *prepartum* on *postpartum* production in first lactation Holstein cows. *Journal of Dairy Science* **76** 236–244

Vazquez-Anon M, Bertics S, Luck M, Grummer RR & Pinheiro J 1994 Peripartum liver triglyceride and plasma metabolites in dairy cows. *Journal of Dairy Science* **77** 1521–1528

Wu Z, Fisher RJ, Polan CE & Schwab CG 1997 Lactation performance of cows fed low or high ruminally undegradable protein prepartum and supplemental methionine and lysine postpartum. *Journal of Dairy Science* **80** 722–729