Effect of Monensin capsules on blood metabolites near calving in twin-pregnant and single-pregnant beef cows

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ABSTRACT

The aim of this study was to test the hypothesis that Rumensin capsules administered during late pregnancy would have equally beneficial effects in single- and twin-pregnant beef cows, on circulating levels of beta-hydroxy butyrate (BOH), magnesium (Mg) and glucose. Forty cows, half of which were twin pregnant, were treated with either a single Rumensin capsule from a mean of 66 d prior to calving, or remained as untreated controls. Plasma samples were taken on d 66, 38, 23, 13 and 5 prior to calving. Rumensin lowered BOH concentration by the second sampling time (0.53 vs. 0.76 mmol/l, $P<0.01$) and maintained this concentration until calving. Rumensin was without effect on Mg or glucose concentrations. The effects of Rumensin were additive to those of pregnancy status (twin vs. single) for all three metabolites thus confirming our hypothesis. Rumensin may therefore be useful in the late pregnancy management of twin pregnant cows.

Keywords: beef cows; nutrition; ketone bodies; monensin; Rumensin; magnesium; glucose; twinning cattle.

INTRODUCTION

In cattle, ketone bodies result from the mobilisation and oxidation of fat reserves. Under conditions of continuing negative energy balance, clinical signs of ketosis may develop. Circulating levels of beta-hydroxy butyrate (BOH) rise under ketotic conditions and the monitoring of this metabolite can be useful in the diagnosis and management of potentially clinical cases (Vermunt, 1987). In a recent study (Morris *et al.*, 1992), BOH has been shown to be elevated in twin-pregnant cows during late pregnancy (0.44 vs 1.35 mmol/l in 1990, $P<0.05$ and 0.46 vs 1.62 mmol/l in 1991, $P<0.001$). In extreme cases, clinical ketosis occurred in twin-pregnant cows but appropriate intervention probably saved the lives of some cows and calves according to these authors. In our own studies during 1992, 51 single- and twin-pregnant cows were monitored frequently from about 200 days prior to calving (W.H. McMillan, unpublished data). In no case was a single observation of elevated BOH (as defined by Morris *et al.*, 1992) recorded earlier than 7 weeks prior to calving. In single-pregnant cows, the mean BOH obtained during this period (ie earlier than 7 weeks prior to calving) ranged from 0.22 up to 0.40 mmol/l compared with a range of 0.25-0.60 in twin-pregnant cows. It is clear from these results that twin-pregnant cows, when compared with single-pregnant cows, do not appear to be more prone to elevations in BOH earlier than about 2 months prior to calving when grazed together on pasture. Within 2 months of calving, mean BOH levels ranged from 0.3 up to 0.6 mmol/l in single-pregnant cows. In twin-pregnant cows, the mean BOH level ranged from 0.48 up to 2.6 mmol/l.

Low serum magnesium can be a problem in cows during late pregnancy and early lactation leading to hypo-magnesaemic grass tetany (Grace, 1983). The data from Morris *et al.*, 1992 indicate that serum magnesium levels do not differ between single- and twin-pregnant cows. There do not appear to be any reports on the susceptibility to hypo-magnesaemic grass tetany of twin- compared with single-pregnant cows.

The Rumensin anti-bloat capsule is an intra-ruminal device designed to administer a controlled and continuous supply of biologically active compound (sodium monensin) to cattle over a period of about 100 days. Rumensin is a rumen modifier with a complex mode of action. It is known to aid in the absorption of magnesium (Greene *et al.*, 1988; Wilson, *et al.*, 1993) and can elevate plasma glucose levels (glycotic effect) (Grings and Males, 1987) and depress circulating ketone levels (anti-ketotic effect) (Sauer, *et al.*, 1989; Wilson, *et al.*, 1993). Importantly, the latter author showed that 19/40 (48%) of control cows had elevated BOH levels (2.0-2.5 mmol/l) compared with 0/39 (0%) treated cows ($P<0.001$). Although elevated, the BOH levels in the affected cows were considered to be "well below the clinical 'ketosis' range" and no clinical ketosis was observed in the trial. It would thus seem that the Monensin capsule may have an important role to play in the management of beef cows in late pregnancy , particularly under conditions where low Mg and elevated ketone bodies are likely. Indeed, Rumensin capsules in twin-pregnant cows may be a particularly appropriate application. Based on the results of Wilson, *et al.*, 1993 BOH is expected to fall by 25% and Mg rise by about 10%.

We reasoned that, if successful, the Rumensin capsule may have a routine place in preventing hypo-magnesaemia and ketosis in beef herds, particularly with twin-pregnant cows. The simplicity of administering a capsule rather than the daily feeding of Mg is likely to have considerable management appeal to beef farmers. If the capsule would allow twin-pregnant cows to remain with single-pregnant cows to term, this is also likely to have appeal to herd owners of twinning cows. This is particularly pertinent given the difficulty of predicting twin-pregnant cows by palpation or ultrasound (McMillan *et al.*, 1994).

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The aims of this study were to test the hypothesis that Rumensin capsules administered during late pregnancy would have beneficial effects on circulating levels of beta-hydroxy butyrate (BOH), magnesium (Mg) and glucose in single- as well as twin-pregnant beef cows grazing pasture.

MATERIALS AND METHODS

Forty mixed age Hereford x Friesian cows, half of which were expected to deliver twins in 1 of 3 batches, were blood sampled for plasma BOH and Mg at a mean of 66 days before calving. Twinning was induced by a combination of artificial insemination and the transfer of a supplementary embryo (McMillan *et al.*, 1993). Having balanced for calving batch, pregnancy status (single vs twin), age (3 year-old vs older), and initial metabolite levels, half of the cows were allocated to be treated with one Rumensin capsule and the other half remained as an untreated control group. Within calving batch, the cows continued to be run together and subsequent blood samples were taken on a mean of 38, 23, 13 and 5 days prior to calving (the days prior to calving at each bleeding time were determined retrospectively once calving date for each cow was known). Each calving batch contained cows pregnant to each of 3 successive synchronised oestrous cycles. The Rumensin capsule was administered using a balling gun and all cows were then observed for one hour on concrete to ensure that no capsules were regurgitated. Each capsule contained 32 g of monensin expected to be released over a 100 day period. All cows were fed a pasture-only diet and no supplemental minerals were provided. Cows were retrospectively classified as single- or twin-pregnant based on actual, not expected, calving data. Data were analysed using Genstat procedures and least squares means are presented.

RESULTS

Effects on BOH

In untreated cows, BOH levels were highest at the first bleeding time and progressively declined until just prior to calving (Table 1). By contrast, Rumensin lowered BOH concentration by the second sampling time (0.53 vs. 0.76 mmol/l, P<0.01) and maintained this concentration until calving. No cows exhibited clinical symptoms of ketosis. Twin-pregnant cows had higher (P<0.05) levels of BOH compared with single pregnant cows until about 2 weeks prior to calving (Table 1). Similarly, younger cows had higher (P<0.05) BOH levels until about 2 weeks prior to calving. Batch differences were inconsistent (Table 1). At each of the bleeding times, there was no relationship between interval from calving and BOH level.

TABLE 1: Effects of Rumensin treatment, pregnancy status, age of cow and calving batch on plasma beta-hydroxy-butyrate levels (mmol/l) before calving.

	66 days pre-calving	38 days pre-calving	23 days pre-calving	13 days pre-calving	5 days pre-calving
Treatment:		P<0.01			
Control	0.89	0.76	0.65	0.60	0.49
Rumensin	1.00	0.53	0.50	0.55	0.44
Pregnancy:	P<0.05	P<0.05	P<0.05		
Single	0.71	0.53	0.43	0.51	0.42
Twin	1.18	0.76	0.71	0.64	0.52
Age:		P<0.05	P<0.05		
3-year-old	1.10	0.80	0.71	0.63	0.49
>3-year-old	0.86	0.56	0.49	0.55	0.44
Batch:	P<0.001			P<0.05	P<0.05
First	0.61	0.70	0.67	0.50	0.56
Second	0.58	0.50	.0.49	0.43	0.49
Third	1.37	0.65	0.51	0.69	0.34

Effects on Magnesium

In general, Rumensin treatment, pregnancy status, and cow age were without effect on magnesium concentrations (Table 2). The 3rd calving batch of cows tended to have higher magnesium levels compared with previous calving batches (Table 2). Other than at the first bleeding time where magnesium levels were lower in cows closer to calving, there was no relationship between interval from calving and magnesium level.

TABLE 2: Effects of Rumensin treatment, pregnancy status, age of cow and calving batch on plasma magnesium (mmol/l) levels before calving.

	66 days pre-calving	38 days pre-calving	23 days pre-calving	13 days pre-calving	5 days pre-calving
Treatment:					
Control	0.52	0.48	0.49	0.56	0.51
Rumensin	0.45	0.56	0.57	0.56	0.58
Pregnancy:					
Single	0.44	0.49	0.51	0.51	0.51
Twin	0.53	0.55	0.55	0.61	0.60
Age:					
3-year-old	0.55	0.58	0.56	0.59	0.57
>3-year-old	0.45	0.49	0.51	0.54	0.53
Batch:		P<0.05	P<0.05	P<0.05	
First	0.46	0.42	0.46	0.49	0.48
Second	0.51	0.63	0.61	0.75	0.63
Third	0.50	0.56	0.55	0.54	0.58

Effects on Glucose

Rumensin treatment and age of cow effects on glucose concentration were small (Table 3). Single-pregnant cows consistently had higher glucose levels than twin-pregnant cows (Table 3). The 1st calving batch of cows generally had higher glucose levels than the later calving batches (Table 3). Other than at the 2nd bleeding time where glucose levels were lower in cows closer to calving, there was no relationship between interval from calving and glucose level.

Interactions

There were no interactions between capsule treatment, pregnancy status, age group and calving batch on metabolite level.

DISCUSSION

This study confirms the role of Rumensin in reducing BOH concentrations during late pregnancy and demonstrates for the first time that this effect also occurs in twin-pregnant cows. The potential for Rumensin to modify rumen function and alter volatile fatty acid metabolic pathways in favour of propionate at the expense of acetate in the rumen has been well established (Schelling, 1984). Similarly, its anti-ketogenic properties have been previously reported in dairy cows (Sauer

TABLE 3: Effects of Rumensin treatment, pregnancy status, age of cow and calving batch on plasma glucose levels (mmol/l) before calving.

	66 days pre-calving	38 days pre-calving	23 days pre-calving	13 days pre-calving	5 days pre-calving
Treatment:				P<0.05	
Control	3.54	3.19	3.43	3.22	3.17
Rumensin	3.47	3.28	3.55	3.36	3.28
Pregnancy:	P<0.05	P<0.01	P<0.01	P<0.05	
Single	3.67	3.44	3.68	3.40	3.29
Twin	3.33	3.04	3.31	3.17	3.15
Age:					
3-year-old	3.46	3.15	3.39	3.27	3.22
>3-year-old	3.52	3.29	3.55	3.30	3.24
Batch:	P<0.01	P<0.05	P<0.05	P<0.01	P<0.05
First	3.97	3.38	3.70	3.51	3.41
Second	3.20	3.42	3.45	3.31	3.08
Third	3.23	3.05	3.33	3.08	3.11

et al., 1989; Wilson *et al.*, 1993). The altered ratio of lipogenic to glycogenic volatile fatty acids in the rumen has been suggested as the mechanism by which this occurs. The findings that twin-pregnant cows had higher BOH levels than single-pregnant cows, and that younger cows had higher levels than older cows are consistent with an earlier report (Morris *et al.*, 1992).

One of the limitations of the design used in this study was that only one (undefined) feeding level was used for all cows. As a consequence, BOH levels progressively declined during the study in the untreated control cows. This makes it difficult to conclude with certainty that Monensin treatment would lower BOH levels in both single- and twin-pregnant cows in the face of a feeding regime that maintained through to calving BOH levels over, for example, 1 mmol/l in untreated cows. To overcome this limitation, future studies could investigate the role of Monensin in single- and twin-pregnant cows over a range of late pregnancy feeding levels. Nonetheless, twin-pregnant cows treated with Monensin capsules in the current study consistently had BOH levels similar to those achieved in untreated single-pregnant cows. This suggests that provided twin-pregnant cows are treated with a Monensin capsule, they can be managed similarly to single-pregnant cows without increasing the risk of ketosis.

Although there was a trend for Rumensin treated cows to have equal or higher magnesium levels compared with untreated cows these differences were not significant at each bleeding time. Other data have shown an increase in circulating magnesium levels which reflects a higher rate of absorption of magnesium (Greene *et al.*, 1988; Wilson, *et al.*, 1993). Whether this higher level of circulating magnesium is of any clinical or productive benefit has not been determined. In the current study hypo-magnesaemic tetany was not an issue in any of the cows. The findings that twin-pregnant cows had similar magnesium levels to single-pregnant cows, and that younger cows had higher levels than older cows are consistent with an earlier report (Morris *et al.*, 1992). The second calving batch of cows consistently had the highest magnesium level throughout the study. No explanation can be offered for this result.

Although there was a trend for Rumensin treated cows to have higher glucose levels these differences were not significant at each bleeding time. Other data from dairy cows indicate a significantly higher circulating glucose level at individual bleed times (Wilson, *et al.*, 1993). A positive effect of glucose level on fertility might have been expected given the data of McClure, 1972. However, no such positive effect was recorded in another New Zealand study (Wilson *et al.*, 1993) nor in Australian studies (Lean *et al.*, 1994; Abe *et al.*, 1994). Reproductive data were not available in the current study. Twin-pregnant cows had lower glucose levels than single-pregnant cows, probably indicating the higher demand for and utilisation of energy substrate in these cows. Although there was a trend for older cows to have higher glucose levels these differences were not significant at each bleeding time, although the pooled data showed this difference to be significant. Calving batch differences were inconsistent and probably reflect differential feeding of the different batches over the late pregnancy period.

SUMMARY AND CONCLUSIONS

This study confirms the role of Rumensin in reducing BOH concentrations during late pregnancy and demonstrates for the first time that this effect also occurs in twin-pregnant cows. We conclude that Rumensin may therefore be useful in the late pregnancy management of twin-pregnant beef cows.

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