

THE EFFECTS OF SODIUM MONENSIN ON GROWTH, AGE AT FIRST CALVING AND MILK YIELD IN FRIESIAN HEIFERS

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SUMMARY

A total of 206 Friesian heifers were involved in three separate studies to monitor growth, age at first calving and first lactation performance in response to treatment with sodium monensin (Rumensin[®]), administered in intra-ruminal, controlled release capsules. Half the growing heifers were dosed two to three times between the ages of 10 and 22 months, with the other half left undosed as controls. The dosed heifers were each given controlled release capsules, designed to deliver 200 to 250 mg/day of Rumensin[®] over 150 days or 300 mg/day over 100 days. The heifers were managed to grow at about 0.6 to 0.7 kg/day until first calving. They were weighed every two months while body condition scores and wither heights were recorded at the time of dosing. Following calving, about half of each treatment group were dosed with a further Rumensin[®] capsule, with the remainder undosed. Milk yields and milk composition were monitored throughout the first lactation. Rumensin[®] treatment had few significant effects on the performance of growing heifers. In two studies, Rumensin[®] increased liveweight gain and body condition for parts of the growth phase. In one study, treated heifers attained heavier pre-calving liveweights (466 v 437 kg at 22 months of age) while in another, they were younger at first calving (727 v 739 days). Rumensin[®] had no effects on yields of milk or milk solids, or on milk composition in any study, either during early lactation or over the first lactation. A combined analyses of entire lactation data from 173 animals in all three heifer groups indicated significant associations between the yields of milk and milk solids and pre-calving liveweight. For milk yield, the partial regression coefficient was 8.7 kg milk/kg pre-calving liveweight. As a result of these studies, it would be difficult to recommend the routine use of Rumensin[®] controlled release capsules to improve the growth, fertility and first lactation performance of Friesian heifers consuming predominantly pasture.

Keywords: dairy heifers, ionophore, growth, fertility, milk yield

INTRODUCTION

Sodium monensin (Rumensin[®]) is an ionophore, which modifies rumen fermentation to increase propionate and decrease methane production. It has been registered for use in lactating cows in Victoria since 1990 and can be administered either as a component of concentrate mixtures or in an intra-ruminal, controlled release capsule. Research with grazing cows in Australia and New Zealand to assess the production responses to Rumensin[®] capsules is inconclusive. Some authors have reported improvements in milk yield (Moate *et al.* 1990; Lowe *et al.* 1994; Hayes *et al.* 1996; Beckett *et al.* 1998), while others have reported little difference (Stevenson and Lowe 1992; Lean *et al.* 1994).

Rumensin[®] capsules are frequently used on dairy farms to control bloat. They may have an additional role in promoting growth and earlier puberty in replacement heifers. In the United States, Rumensin[®] capsules have been found to improve growth rates in grazing beef cattle (Parrott *et al.* 1992), while daily administration of Rumensin[®] has reduced ages at puberty in dairy heifers (Baile *et al.* 1982; Meinert *et al.* 1992). In summarising available data, Heinrichs (1996) found improvements in growth rates of dairy heifers of 0.05 to 0.09 kg/day when treated with ionophores such as Rumensin[®]. With increasing interest in reducing ages at first calving and/or increasing pre-calving live weights of replacement heifers in Australia (Moran and McLean 2001), it was decided to test the hypothesis that Rumensin[®] capsules increased growth rates, reduced age at first calving and increased first lactation milk yields of Friesian heifers.

MATERIALS AND METHODS

Herd management during the growing phase

Four to six month old Friesian heifers were reared under contract on a commercial property in northern Victoria (Studies A and B), or at the Kyabram Dairy Centre (Study C). The 83 heifers used in Study A were born in spring 1993, while the 77 heifers used in Study B and the 46 heifers in Study C were born during spring 1994. Half of the number of heifers were dosed two to three times with Rumensin[®] capsules between the ages of 10 and 22 months.

The yearling heifers were stratified on the basis of age and live weight, with every first and fourth animal in each stratum of four animals selected for dosing. The dates of initial dosings with corresponding mean ages and heifer live weights were respectively, 28 July 1994, 336 days and 230 kg in Study A, 13 June 1995, 287 days and 196 kg in Study B and 15 September 1995, 373 days and 247 kg in Study C. The selected heifers in Study A were redosed on 20 December 1994 and again on 13 June 1995, while in Study B, they were redosed on 26 October 1995 and again on 15 February 1996. In Study C, heifers were only dosed twice pre-calving, with the second dosing on 28 February 1996.

All herds grazed irrigated perennial or annual pastures and were fed supplements of grain, hay or silage to maintain a growth rate of 0.6 to 0.7 kg/day. They were strategically treated for internal and external parasites and vaccinated for *Salmonella* and *Clostridia*. Heifers were weighed every two months, while body condition score (using the 8 point score of Earle 1976) and wither height were recorded on each animal at the times of dosing. Heifers were synchronised for oestrus on average, at 15 months of age, artificially inseminated and then run with Jersey bulls for the following two months. Final pre-calving measurements were made on 13 June 1995, 16 July 1996 and 13 June 1996 for Study A, B and C respectively. The heifers in Studies A and B were returned to the home farm, near Kyabram, just prior to calving.

The capsules were 16 cm long plastic capsules, with retractable wings on one end, containing a solid core of 32 g sodium monensin in a hexaglycerol disteate matrix. They were designed to deliver a dose of 200 to 250 mg of Rumensin[®]/day into the rumen for 150 days. The third capsules given to heifers in Studies A and B and to all lactating heifers were commercial Elanco anti-bloat capsules which deliver about 300 mg Rumensin[®]/day for 100 days.

Herd management during lactation

Following calving, half the number of heifers in Study A were dosed with capsules on 11 October 1995, after stratification on the basis of live weight and days of lactation. About half of those that had previously been in treated or control groups received capsules, with the remainder left undosed. Rather than wait until all heifers had calved in Studies B and C, the selected lactating heifers were dosed with capsules within 10 days after calving. The total number of available lactating heifers were 68, 75 and 33 for Studies A, B and C respectively, because 5 died during the study and 25 failed to calve prior to Rumensin[®] treatment. Heifers grazed with the mature cows in each milking herd and were supplemented with pasture silage (Studies A and B), maize silage (Study C) and cereal grain (Studies A, B and C).

Heifers were individually herd recorded every two (Study C) or four (Studies A and B) weeks throughout lactation. Milk samples were analysed for protein, fat and milk urea concentrations (the latter only in Studies A and C). Early lactation was considered to be the first 80 to 100 days post-calving, after which live weights, condition scores and wither heights were recorded. Full lactation data, adjusted to a 300 day lactation, were calculated from herd test data until drying off in June 1996 (Study A) or June 1997 (Studies B and C).

Statistical analyses

Liveweight changes between capsule dosings were calculated as the difference between live weights at the beginning and end of each dosing period. Differences between treated and control heifers for changes in and for final live weight, body condition score and wither height were tested using one way analyses of variance. Age at first calving were compared within herds by t tests.

Effects of treatments on yields of milk and milk solids, milk composition, liveweight, condition score and wither height during early and the complete lactation were compared using factorial analyses of variance with two factors, namely the period of dosing (while growing or lactating) and whether heifers

were dosed or not dosed during either of these periods. Because of unequal group sizes, these analyses were undertaken using residual maximum likelihood analyses.

Entire lactation data from all three groups of heifers (173 heifers) were combined and statistically analysed using a linear regression model which removed effects of Rumensin[®] treatment prior to quantifying the influence of pre-calving liveweight on yields of milk and milk solids.

RESULTS

Performance of growing heifers

Rumensin[®] treatment had few significant effects on the performance of growing heifers. Treated heifers in Study A were younger ($P < 0.05$) at first calving than were untreated heifers, while treated heifers in Study C had heavier ($P < 0.05$) pre-calving liveweights (Table 1). During the 144 day period between the first and second dosings in Study A, treated heifers grew faster ($P < 0.001$, 0.97 v 0.87 kg/day) and put on more body condition ($P < 0.001$, 1.0 v 0.6 units). In Study C, treated heifers grew faster ($P < 0.05$, 0.69 v 0.56 kg/day) during the 105 days following the second dosing.

Table 1. Pre-calving liveweights (kg), wither heights (cm) and calving ages (days) and standard error of differences (SED) of heifers in each study when dosed with Rumensin[®] capsules (Rum) or left undosed as controls (Con). Significant ($P < 0.05$) differences within studies are indicated by different superscripts

Study	A			B			C		
	Rum	Con	SED	Rum	Con	SED	Rum	Con	SED
Pre-calving liveweight	421	414	7.9	497	504	8.5	466 ^A	437 ^B	11.7
Pre-calving wither height	131	129	0.9	135	135	0.9	134	133	1.1
Calving age	727 ^A	739 ^B	4.9	731	722	5.1	708	696	7.3

Performance of lactating heifers

Rumensin[®] treatment, either pre- or post-calving, had no effect on yields of milk or milk components or on milk composition during early lactation in any of the three studies. Mean daily yields of milk and contents of milk protein and fat (\pm SD) were respectively, 18.5 (± 2.3) kg, 3.1 (± 0.21)% and 4.1 (± 0.44)% in Study A, 22.2 (± 3.0) kg, 3.1 (± 0.18)% and 3.8 (± 0.40)% in Study B and 18.0 (± 2.5) kg, 3.1 (± 0.13)% and 4.0 (± 0.56)% in Study C. Milk urea contents averaged 33 (± 3.2) mg/dL in Study A and 25 (± 3.0) mg/dL in Study C. There were no effects of Rumensin[®] treatment on liveweight, wither height or body condition score during early lactation

The complete lactation performance of heifers was also unaffected by Rumensin[®] treatment, averaging 5037 (± 698) kg milk in Study A, 5513 (± 678) kg in Study B and 3998 (± 522) kg in Study C. However, there were significant ($P < 0.001$) linear relationships between pre-calving liveweight (ranging from 380 to 550 kg) and full lactation yields of milk and milk solids. The partial regression coefficients for liveweight (\pm s.e.), the percent variance accounted for (r^2) and the residual standard deviation (r.s.d.) for each linear regression was as follows:

	<u>Regr coeff (\pm SE)</u>	<u>r^2</u>	<u>r.s.d.</u>
Milk yield	8.7 (± 1.29)	0.52	596
Milk protein yield	0.26 (± 0.035)	0.63	16
Milk fat yield	0.26 (± 0.048)	0.51	22

DISCUSSION

Rumensin[®] for growing heifers

There were few instances when Rumensin[®] treatment improved the pre-calving performance of dairy heifers. Parrott *et al.* (1992) summarised the results of 28 trials assessing Rumensin[®] capsules in grazing beef steers and heifers, reporting growth rate advantages of 0.04 to 0.09 kg/day while control animals were growing at between 0.2 and 1.3 kg/day. They concluded, firstly, that Rumensin[®] was beneficial so long as animals were gaining weight, and secondly, that growth rate advantages were not dependent on the magnitude of the growth rate. In the current studies, the effects of growth rate on responses were inconclusive. On only 2 occasions did Rumensin[®] improve growth rates in heifers gaining 0.6 kg/day of more, while in many instances, heifers were growing at between 0.3 and 0.9 kg/day with no beneficial

effects of Rumensin[®]. This inconsistency of results requires further attention, for example, to ascertain the dietary implications of adequate levels of rumen propionate on growth responses to Rumensin[®].

Although Meinert *et al.* (1992) found little effect of Rumensin[®] on Friesian heifer growth rates, it was associated with a 48 day reduction in age at first calving, from 751 to 703 days. This is considerably more than the 12 day reduction recorded in Study A, which based on the number of animals involved may not be biologically significant or repeatable. Generalisations about the beneficial effects of Rumensin[®] on fertility of growing heifers are difficult to make because they are also influenced by diet quality and body condition (Spratt *et al.* 1988). Furthermore, the present results should be treated with caution given the relatively small number of animals involved.

Rumensin[®] for lactating heifers

In all three studies, whether administered before or after calving, Rumensin[®] had no effect on yields of milk or milk solids, or on milk composition. Baile *et al.* (1982) reported that Rumensin[®] improved growth rates of lot fed Friesian heifers before calving but there were no carryover effects on milk yields or fertility in early lactation.

Research assessing Rumensin[®] administered in capsules to grazing cows in Australia and New Zealand has been inconclusive, while no trial has specifically evaluated Rumensin[®] in first lactation heifers. These animals may respond differently to mature cows, as they are still growing as well as producing milk. Some of the positive milk responses to capsules have been related to reduced bloat in treated cows (Lowe *et al.* 1994), but there was little evidence of bloat in any of the control heifers in the current studies.

The benefits arising from improved growth rates and reduced ages at first calving have been summarised by Moran and McLean (2001). The partial regression coefficient for pre-calving liveweight on first lactation milk yield recorded in these studies (9 kg extra milk/kg heavier liveweight at first calving) is similar in magnitude to the average value recorded in previous Australian studies (Moran and McLean 2001).

Even though Rumensin[®] has been shown to improve pre-calving performance in the overseas studies cited above, the inconsistent results from the present studies would make it difficult to recommend the routine use of Rumensin[®] capsules to improve the growth, fertility and first lactation yields of Friesian heifers consuming predominantly pasture.

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