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Australian Journal of Experimental Agriculture

Volume 37, 1997

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Adding bentonite to sorghum grain-based supplements has no effect on cow milk production

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Summary. Twenty-four Holstein–Friesian cows were used in an experiment comparing milk production from cows offered rolled sorghum grain either alone at 8 or 10 kg/head.day of air-dried grain or with 4% sodium bentonite. The design was a 4 x 4 latin square with a 1 week adjustment period and a 3 week treatment period. This design was used to highlight the effects of high levels of grain feeding and changing that level of grain or grain–bentonite every 4 weeks. Cows grazed either ryegrass (*Lolium multiflorum* cv. Tetila) or oats (*Avena sativa* cv. Cluan) during the day and a mixed ration based on maize silage, lucerne hay, and meat and bone meal at night.

There was no significant effect of treatments on milk yield or composition. Cows fed bentonite had a higher (P<0.05) rumen pH, tended to eat less grain sorghum and have lower concentrations of rumen ammonia and faecal starch. Faecal crude protein tended to increase with the use of bentonite indicating cows may have substituted pasture or mixed ration for grain and maintained a more stable rumen fermentation.

Introduction

The Australian dairy industry has shown a clear trend to a higher use of grain in the diet of cows (Anon. 1995). In Queensland, on average 1.5 t grain/cow was used in 1990 (Kerr and Chaseling 1992), with some farms feeding up to 3 t/cow. A previous experiment at this centre showed that feeding high levels of sorghum grain to grazing cows resulted in loss of 18% starch in the faeces (Davison *et al*. 1994). Other deleterious effects of feeding high levels of grain include rumen acidosis and a lowering of milk fat concentrate (Storry and Rook 1965). Sodium bentonite (NaB) (Australian Bentonite Pty Ltd, Brisbane) is a colloidal, hydrated, aluminium silicate clay consisting principally of montmorillonite and has a high ion exchange and moisture absorbing capacity (Bringe and Schultz 1969). In northern America, experiments with dairy cattle fed in feed lots have shown that bentonite increased milk fat concentrate and milk yield when cows were fed high concentrate, low roughage rations (Bringe and Schultz 1969; Rindsig *et al*. 1969; Rindsig and Schultz 1970). In contrast, Australian studies with cows grazing pasture have shown no benefit of supplementary bentonite with either milk fat concentrate or milk yield (Lemerle *et al*. 1984; Moate *et al.* 1985; Hamilton *et al.* 1988). These studies were conducted with cows producing 12–21 kg/day and fed grain-based concentrates of between 4 and 6 kg/head.day. This experiment evaluated the effects on milk production and composition of feeding sodium bentonite to cows fed 8–10 kg/day of a sorghum-based concentrate and producing over 25 kg milk/cow.day.

Materials and methods

Location and management

The experiment was carried out on Mutdapilly Research Station in south-east Queensland. Twenty multiparous and 4 primiparous cows, 4–10 weeks into lactation, were blocked on parity, milk yield, milk fat content and liveweight during the 2 weeks before the experiment, and randomly allocated to 4 treatment groups of 5 cows and 1 heifer. In this fortnight, all cows received 4 kg of rolled sorghum in individual feed stalls after morning milking. A mixed ration (MR), with an average crude protein of 14% and a neutral detergent fibre (NDF) content of 46% (Table 1), was fed at night from calving and throughout the experiment on a group basis. Cows grazed ryegrass (*Lolium multiflorum* cv. Tetilla) or oat (*Avena sativa* cv. Cluan) pastures during the day at a stocking rate of 3 cows/ha.

Design and treatments

A 4 x 4 latin square design was used with a 1 week adjustment period and a 3 week treatment period with cows receiving each treatment once. Treatments consisted of the following supplements (air-dried basis; per cow per day): (i) 8 kg grain (8G); (ii) 8 kg grain plus 320 g bentonite (8B); (iii) 10 kg grain (10G); and (iv) 10 kg grain plus 400 g bentonite (10B). Sorghum grain from the same batch was used throughout the experiment. A proprietary mineral mix (Dairy Pac Hyfeed, Toowoomba) consisting of 20% calcium, 11.65% phosphorus, trace minerals and vitamins was added to make up 1% of the mixed concentrate ration. Half of the daily feed allocation was offered in

10.1071/EA96140

Table 1. Mixed ration offered on feedpad at night

Component	Composition (% DM)	Estimated intake (kg DM/cow.day)
Maize silage	65.0	6.55
Lucerne hay	20.8	2.10
Meat and bone meal	5.2	0.52
Molasses	8.6	0.86
Salt	0.25	0.25
Magnesium sulfate	0.2	0.20
Total	100.0	10.07

Table 2. Chemical composition (% DM) of ration ingredients

ADF, acid detergent fibre; NDF, neutral detergent fibre; IVDMD, *in vitro* dry matter digestibility

Ingredient	Crude protein	ADF	NDF	Ether extract	IVDMD
Lucerne hay	21.56	32.4	37.4	1.3	60.3
Maize silage	8.69	23.5	59.6	2.7	63.7
Pasture[A]	22.73	26.17	39.2	3.25	68.07
Sorghum grain	12.5	—	—	—	—
Molasses	9.69	—	—	—	—
Meat and bone meal	52.75	—	—	8.7	—
Bentonite	<0.06				

[A] Mean of 4 samples.

individual stalls after milking at 0730 hours and half at 1430 hours before evening milking. Rejects were weighed and recorded after each feed.

Measurements

Once each week, pasture on offer was estimated before grazing using 10 quadrats (0.25 m^2) cut to 1 cm stubble height and dried at 80°C for 24 h in a forced draught oven. In week 2 of each round, samples of pasture, lucerne hay and maize silage were analysed for protein, acid detergent fibre and NDF, ether extract and *in vitro* dry matter digestibility (Minson and McLeod 1972) (Table 2). Samples of grain sorghum, molasses, meat and bone meal, and bentonite were analysed for crude protein, and meat and bone meal was also analysed for ether extract (Table 3). Rejects from the MR were collected and weighed once each week and dry matter determined to estimate intake.

In weeks 8 and 16 of the experiment, samples of rumen liquor and faeces were taken immediately before and 4 h after the morning feeding of supplements. Rumen liquor was analysed for pH and ammonia concentration (Bolleter *et al.* 1961). Faecal samples were analysed for starch (Englyst and Cummings 1988; McCleary *et al.* 1992) on both occasions and for crude protein at the second sampling.

Results

Milk yield, fat-corrected milk yield, fat yield and fat composition were not influenced by the addition of bentonite to the grain (P>0.05; Table 3). Concentrate intake of cows fed bentonite approached significance (8.00 *v.* 8.48 kg/head.day) and was lower than control cows (P = 0.097). Rumen pH was significantly (P<0.05) increased by feeding bentonite and with level of grain fed (Table 4). Overall rumen ammonia was not significantly different between treatments and showed a trend to lower concentration with both the addition of bentonite and extra grain in the diet (Table 4). At the afternoon sampling, cows fed 10 kg of grain had significantly (P<0.05) lower rumen ammonia than cows fed 8 kg of grain (11.1 *v.* 12.5 mmol/L), however, the difference was not significant at the morning sampling (4.7 *v.* 4.9 mmol/L). Mean rumen ammonia and pH were significantly (P<0.05) different between morning and afternoon samplings, being 4.7 and 11.8 mmol/L for ammonia and 7.1 and 6.7 for pH, respectively. Faecal crude protein percentage was not significantly (P>0.05) different between treatments (Table 4). For faecal starch treatment 8B compared with 10G approached significance (P = 0.1) (Table 4).

Pasture on offer per cow ranged from 4.6 to 15.7 kg dry matter (DM)/cow.day with an average of 10.8 kg DM/cow.day. Total intakes from pasture, grain and MR were calculated to range from 21 to 24 kg DM/cow.day (Neal *et al.* 1984). Estimated dietary crude protein ranged from 15.3 to 16%, NDF was about 34% and forage : grain ratio about 50 : 50. Cows gained weight throughout the experiment with an average weight of 537 kg at the commencement of the experiment and a final weight of 602 kg/head. Liveweight gains were not significantly (P>0.05) different at 0.3, 0.38, 0.49 and 0.32 kg/day for treatments 8G, 8B, 10G and 10B, respectively.

Table 3. Effect of adding 4% bentonite to sorghum grain fed at either 8 or 10 kg/head.day on milk yield and composition

Treatments: 8G, 8 kg grain; 10G, 10 kg grain; 8B, 8 kg grain + 320 g bentonite; 10B, 10 kg grain + 400 g bentonite

FCM, fat-corrected milk

Measurement	8G	10G	8B	10B	s.e.d.
Milk (L/day)	27.2	27.8	26.9	27.5	0.49
FCM (L/day)	24.9	25.5	25.1	25.3	0.55
Fat					
kg/day	0.97	0.99	0.99	0.98	0.03
%	3.47	3.46	3.57	3.47	0.60
Protein					
kg/day	0.88	0.90	0.87	0.89	0.01
%	3.17	3.14	3.14	3.14	0.02
Lactose					
kg/day	1.37	1.41	1.36	1.39	0.03
%	4.90	4.90	4.88	4.89	0.02

Table 4. Effect of adding bentonite to two levels of grain sorghum feeding on rumen and faecal parameters of lactating dairy cows

Grain level (kg/day)	Bentonite level (%)	Concentrate intake (kg DM/day)	Rumen pH	Rumen Ammonia-N (mmol/L)	Faecal Starch (% DM)	Faecal Crude protein (% DM)
8	0	7.55	6.76	8.75	22.3	18.1
8	4	7.34	6.94	8.54	17.2	18.9
10	0	9.41	6.90	8.10	24.8	16.8
10	4	8.66	7.07	7.67	19.4	17.4
l.s.d. (P = 0.05)		n.s.	0.125	n.s.	n.s.	n.s.

Discussion

The addition of sodium bentonite to sorghum grain did not increase milk production or alter milk composition of cows receiving a forage : grain ratio of about 50 : 50. These results agree with Hamilton *et al.* (1988) who fed 4 or 6 kg maize to cows grazing ryegrass–clover pasture in the day and kikuyu pasture at night to achieve forage : concentrate ratios of about 60 : 40. Cows were producing 20 kg milk/day. Lemerle *et al.* (1984) also fed a ration with a forage : grain ratio of 60 : 40 and found that bentonite did not increase milk yield or the milk fat concentration of cows fed high quality pasture in either early (20 kg milk/cow.day) or late lactation (11 kg milk/cow.day). In contrast, Rindsig *et al.* (1969) and Bringe and Schultz (1969) fed rations with low forage : grain ratios (25 : 75) and found increases in both milk yield and milk fat concentration.

Grain intake of bentonite-fed cows were lower which may be attributed to a slower rate of passage in the rumen (Bringe and Schultz 1969). Hamilton *et al.* (1988) also found that bentonite-fed cows had lower grain intakes at a feeding level of 6 kg/cow.day. There was no apparent evidence of a carryover effect of bentonite treatment to other treatments. Cows moving from bentonite to straight grain treatments tended to eat more grain. In our experiment rumen pH increased with both the addition of bentonite and increased grain. Bentonite has been shown to maintain rumen pH in other studies (Bringe and Schultz 1969). There is no obvious explanation for an increase in pH with increasing grain feeding. However, the sampling time preceded grain supplement feeding and cows were eating a MR containing high fibre levels before sampling and this may have stimulated saliva production and increased rumen pH (Bailey 1961).

Overall rumen ammonia tended to be lower with bentonite feeding and may reflect an absorption of ammonia by bentonite (Rindsig and Schultz 1970). This was also reflected in higher faecal crude protein concentration. Rumen ammonia was also lower for cows fed 10 kg compared with 8 kg grain and would reflect better utilisation of dietary protein and suggest a substitution of pasture for grain and MR (Moss *et al.* 1992).

Faecal starch tended to be lower in the groups fed bentonite but this was not translated into increased milk production as in the study of Rindsig and Schultz (1970). It would appear that as grain feeding increased so did faecal starch. Similar high faecal starch levels were found by Davison *et al.* (1994) for rolled sorghum grain fed at 5 kg/day and indicate that for this grain there are substantial losses in feed energy when sorghum grain is rolled compared with processing by steam pelleting or flaking, where faecal starch was reduced to less than 5% (Moore *et al.* 1992; Davison *et al.* 1994).

Conclusions

Feeding sodium bentonite did increase rumen pH, tended to lower rumen ammonia, increase faecal protein and decrease faecal starch. In dairy rations where forage content is about 50% of the total diet and milk yields are 25–30 kg/day, sodium bentonite is not effective in improving milk yield or composition when sorghum grain was fed as the concentrate.

Acknowledgments

We thank Mr W. Orr for technical support and Mutdapilly staff for the care of the animals. Financial support for this project was provided by Australian Bentonite.

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Received 11 November 1996, accepted 2 May 1997