Response By Dairy Cows Grazing Tropical Grass Pasture To Barley or Sorghum Grain Based Concentrates and Lucerne Hay[a]

R. J. Moss[1], I. J. C. Hannah[1], S. J. Kenman[2], I. K. Buchanan[1] and P.R. Martin[3]
[1] Australian Tropical Dairy Institute, DPI, Mutdapilly Research Station, M S 825, Peak Crossing, Qld. 4306
[2] Dept Agriculture, University of Qld, St Lucia, Brisbane, Qld. 4067
[3] Dept. Primary Industries, Animal Research Institute, Yeerongpilly, Qld. 4105

ABSTRACT: This study investigated the responses by dairy cows grazing Callide Rhodes grass (*Chloris gayana* cv. Callide) pasture to supplementation with barley or sorghum based concentrates (5 grain:1 cotton seed meal) or barley concentrate plus lucerne (*Medicago sativa*) hay. It was conducted in summer - autumn 1999 with 20 spring calved cows in 4 treatments in 3 consecutive periods of 4 weeks. Rain grown pastures, heavily stocked at 4.4 cows/ha, provided 22 to 35 kg green DM and 14 to 16 kg green leaf DM/cow.day in periods 1 to 3. Supplements were fed individually twice daily after milking. Cows received 6 kg concentrate/day in period 1, increased by 1 kg/day as barley, sorghum or lucerne chaff in each of periods 2 and 3. The Control treatment received 6 kg barley concentrate in all 3 periods. Milk yields by cows fed sorghum were lower than for cows fed equivalent levels of barley-based concentrate ($P<0.05$). Faecal starch levels (14, 18 and 17%) for cows fed sorghum concentrate were much higher ($P<0.01$) than those of cows fed similar levels of barley (2.1, 1.2 and 1.7%) in each period respectively. Additional supplementation as lucerne chaff did not increase milk production ($P>0.05$). Increased concentrate supplementation did not alleviate the problem of low protein in milk produced by freshly calved Holstein-Friesian cows grazing tropical grass pasture in summer.

Key Words: Milk, Tropical Pasture, Concentrate, Barley, Sorghum, Faecal Starch

INTRODUCTION

Dairy production systems in northern Australia have been developed using perennial tropical grass pastures in summer and irrigated temperate pastures in winter for year round milk supply (Moss and Lowe, 1993). The primary limitation to production from this pasture based system is intake of digestible energy, particularly with high fibre, low digestible tropical grasses. Leaf content and grass quality decline further in late summer – autumn with flowering and senescence (Moss *et al*., 1992, Cowan *et al*., 1993). Concentrates have been adopted as an integral component of subtropical dairy production systems, permitting increased production per cow with higher stocking rates to increase pasture utilisation for higher milk output per cow and per farm (Moss *et al*., 1992, 1994; Moss and Lowe, 1993; Cowan *et al*., 1998). Higher stocking rates however may exacerbate the problems of declining pasture yield and quality in autumn. Effects of this might be reduced by increased supplementation at this time.

On dairy farms, sorghum and barley, the main cereal grains used are commonly alternated according to seasonal availability and price. Such dietary changes may impact on utilisation of grain and hence milk production. In this study, spring calved cows previously fed barley grain as part of a partial mixed ration (PMR) were individually offered concentrates based on barley or sorghum grain. Responses by cows to increased supplementary feeding as concentrate or high quality conserved forage (lucerne hay) to maintain ME intake and/or forage to grain ratio with declining pasture availability were also investigated in 3 experimental periods. Faecal samples were collected and analysed for nitrogen and starch content as indicators of concentrate utilisation.

MATERIALS AND METHODS

The experiment was conducted at Mutdapilly Research Station, 80 km south west of Brisbane (latitude 27° 46'S; longitude 152° 40'E; altitude 40 m). Average rainfall is 800 mm per year, occurring mainly through summer. Twenty multiparous Holstein-Friesian cows, calving in spring 1998 were stratified on milk production, age and live weight and allocated to one of 4 supplement treatments:-

i) Control - 6kg barley based concentrate (5 barley: 1 cottonseed meal (CSM)).
ii) Barley based concentrate (5 barley:1 CSM) – 6, 7, 8 kg/cow.day.
iii) Sorghum based concentrate (5 sorghum:1 CSM) – 6, 7, 8 kg/cow.day.
iv) Barley based concentrate (6 kg) + Lucerne chaff (*Medicago sativa*) – 0, 1, 2 kg/cow.day.

Supplements were individually fed twice daily at approximately 7:00 and 16:00 hours after each milking. A proprietary mineral supplement was added to all concentrates at 100 gm/cow.day.

Cows grazed raingrown Callide Rhodes grass pastures (*Chloris gayana* cv. Callide) at a stocking rate of 4.4 cows/ha. The grass was an established pasture on a heavy black clay alluvium (Ug 5.l6) (Northcote, 1979). Pastures were top dressed annually with 260 kg of a mixed fertiliser supplying 39 kg N, 4 kg P, 30 kg K and 35 kg S in spring. Urea was applied after grazing, at 50 kg N/ha every 4 weeks from December 1998 to March 1999. The pasture area was replicated as 2 blocks subdivided into 4 equal paddocks and grazed in a 2 week in, 2 week out rotation. Treatments were randomly allocated to paddocks and cows were maintained as separate treatment groups. In the 4 weeks prior to commencement of the study (December 1998), cows grazed other pastures including irrigated temperates. They were fed a 50/50 mix of sorghum and barley (5 kg grain/cow.day) as part of a PMR during this preliminary period. Treatments were imposed and measurements conducted as 3 consecutive 4 weekly periods from January to March 1999.

Period 1 (4/1/99 - 31/1/99). All cows were fed 6 kg/day of 5:1 grain/cottonseed meal (CSM – 43% CP) concentrate. In treatments 1, 2, & 4 the grain component was rolled barley (12.1% CP; 13.0 MJ ME/kg DM) and in treatment 3 it was rolled sorghum (11.8% CP; 14.0 MJ ME/kg DM).

Period 2 (1/2/99 - 28/2/99). In treatments (ii) Barley and (iii) Sorghum, concentrate level was increased to 7 kg/cow.day while in treatment (iv) Barley + lucerne hay, 1 kg lucerne chaff (24.7% CP; 9.25 MJ ME/kg DM) (0.5 kg per feed) was fed with the 6kg concentrate.

Period 3 (1/3/99 - 28/3/99). Concentrate level was again increased by 1 kg to 8 kg/cow.day for treatments (ii) and (iii), and lucerne chaff increased to 2 kg/cow.day for treatment (iv). Sodium bicarbonate was added to the concentrate supplement at 150 g/cow.day for all cows in Period 3 only.

All supplements were offered as 2 equal feeds per day with rejects from a feed period offered at the next feeding, unless acidosis was indicated. Nett concentrate rejection was therefore minimal. Concentrate rejection was usually associated with periods of hot weather with reduced intake in the afternoon. Maximum/minimum temperatures averaged 31^{o}C/22^{o}C from January to March.

Measurements.

Pasture dry matter (DM) on offer in each treatment paddock at each rotation was measured by cutting 10x0.25 m^2 quadrats to 5 cm. A sub sample of pasture on offer was hand sorted into its botanical components (leaf, stem, dead, weeds) and dry matter on offer and composition determined by oven drying at 80°C for 36 hours.

Samples of dried pasture were ground (1mm screen) and analysed (wet chemistry) for Nitrogen (N) (combustion analysis, Dumas method), *in vitro* DM and OM digestibility (IVDMD/IVOMD) content and ME (MJ ME/kg DM) calculated. Samples of lucerne chaff fed were similarly analysed while sorghum, barley and cottonseed meal were analysed for nitrogen content and ME calculated from proximate analysis of crude fibre.

Milk yields were automatically recorded at every milking and live weights 5 mornings per week after am milking. A composite sample of milk taken at 2 consecutive milkings each week (Tuesday pm, Wednesday am) was analysed for milkfat, protein and lactose (Milkotester Mk III - Foss electric). A grab sample of faeces was collected from each cow at feeding (am + pm) on days 24-26, bulked and oven dried at 80^{o}C for 48 hours, ground and subsequently analysed for nitrogen and starch content. Milk yield and faecal composition were analysed by analysis of variance using the cow as the replicate as concentrates were individually fed.

RESULTS

Regular rainfall events (741 mm December - March inclusive) permitted the high stocking rate of 4.4 cows/ha to be carried in periods 1 and 2. Stocking pressure was increased in period 3 by reducing the paddock area by 10%. Pastures supplied around 2 t/ha of green leaf at entry to each paddock (Table 1), allowing cows a diet with up to 16 kg green leaf/day in all experimental periods. This leaf was of only modest quality at 11% crude protein and 8 MJ ME/kg DM, with little difference in quality from January to March (Table 1).In period 1, when all treatment groups received 6kg concentrate (5 grain:1CSM), milk yields initially were lowest ($P<0.05$) for cows fed the sorghum based concentrate (Table 2). Milk yield increased with additional concentrate supplementation as barley ($P<0.05$) with 0.6 L milk/kg concentrate in period 2 and 0.9 L milk/kg concentrate at the end of period 3 (Table 2). Milk yields by cows offered 7 kg sorghum concentrate in period 2 were lower than control cows (6 kg barley), with a response of 0.3 L milk/kg sorghum concentrate in period 3 ($P<0.05$). Supplementation with lucerne hay in addition to the 6 kg barley concentrate had little effect on milk production in either period (Table 2).

Milk protein levels of these recently calved cows were low in all treatments and lowest in January, tending to increase with time (Table 3). Level and type of supplement did not significantly influence milk protein or milk fat contents (Table 3). Faecal starch ($P<0.01$) and nitrogen ($P<0.05$) concentrations were highest in cows fed concentrates with rolled sorghum (Table 4).

Table 1. Quantity and quality attributes of the Callide Rhodes grass pasture on offer in each experiment period

Period	Stocking Rate cows/ha	Green DM on offer kg/ha	Green Leaf DM on offer kg/ha	Leaf DM per cow kg/day	Leaf CP %	Leaf ME MJ/kg DM	Stem CP %	Stem ME MJ/kg DM
1. January	4.5	2703	1800	13.6	11.1	8.1	6.8	7.5
2. February	4.5	3949	2119	16.4	10.5	7.7	5.5	7.0
3. March	5.0	4830	2331	16.2	11.1	8.1	5.5	6.8

Table 2. Average milk yield (L/cow.day) for cows in each supplementation treatment in the 2nd and 4th weeks of each experimental period

Treatment	At Commencement		Milk Yield (L/cow.day) Period 1 6 + 0 kg		Period 2 6 + 1 kg		Period 3 6 + 2 kg	
	Days in lactation	Milk (L/day)	Week 2	Week 4	Week 2	Week 4	Week 2	Week 4
(i) Control	88	28.7	25.3[b]*	23.3	22.2[ab]	21.1[a]	19.6[b]	18.6[a]
(ii) Barley	82	28.8	25.1[b]	23.4	22.8[b]	21.7[b]	20.9[b]	20.4[c]
(iii) Sorghum	83	27.8	23.6[a]	23.1	21.7[a]	20.6[a]	20.0[a]	19.2[b]
(iv) Barley + Lucerne hay	88	28.3	25.1[b]	23.4	21.7[a]	20.8[a]	19.8[a]	18.8[ab]
LSD $_{5\%}$		1.20	1.21	0.84	0.76	0.58	0.56	0.57

*abc Means in columns with differing super scripts are significantly different (P<0.05).

Table 3. Effect of supplementation on milk fat and protein concentrations

Treatment	Period 1 January Week 1		Period 1 January Week 4		Period 2 February Week 4		Period 3 March Week 4	
	Milk Fat %	Protein %	Milk Fat %	Protein %	Milk Fat %	Protein %	Milk Fat %	Protein %
(i) Control	4.44	2.78	3.44	2.74	3.90	2.98	4.34	3.15
(ii) Barley	4.25	2.74	3.83	2.66	3.97	2.88	4.69	2.99
(iii) Sorghum	4.30	2.85	3.98	2.74	4.05	2.97	4.47	3.14
(iv) Barley + Lucerne hay	4.18	2.89	3.71	2.85	4.32	3.04	4.29	3.15
LSD $_{5\%}$	1.17	0.26	0.72	0.23	0.66	0.24	0.71	0.27

Table 4. Effect of supplementation on faecal nitrogen and starch concentrations

Treatment	Period 1 January Faecal Nitrogen (%)	Faecal Starch (%)	Period 2: February Faecal Nitrogen (%)	Faecal Starch (%)	Period 3: March Faecal Nitrogen (%)	Faecal Starch (%)
(i) Control	1.99[a*]	1.72[a]	1.85[a]	0.90[a]	1.84[a]	1.18[a]
(ii) Barley	2.01[a]	1.92[a]	2.12[b]	1.24[a]	2.01[b]	1.68[a]
(iii) Sorghum	2.25[b]	14.06[b]	2.26[b]	18.32[b]	2.38[c]	17.38[b]
(iv) Barley + Lucerne hay	2.00[a]	1.80[a]	1.90[a]	0.90[a]	1.89[ab]	1.36
sed	0.080	0.922	0.076	.683	0.077	1.575
LSD $_{5\%}$	0.176	2.008	0.167	1.488	0.168	3.431

*abc Means in columns with differing super scripts are significantly different (P<0.05).

DISCUSSION

Although leaf percentage of the pasture declined, increased pasture growth over the period of the experiment maintained green leaf content around 2 tonnes/ha, offering cows up to 16 kg green leaf per day from the pasture. The stocking rates of 4.4 then 4.9 cows/ha imposed ensured that utilisation of green leaf grown during the 3 month experiment was relatively high. The unutilised dry matter on offer was mainly stem of lower nutritive value (5.9% CP; 7.1 MJ ME/kg DM) as the cows preferentially selected green leaf (Cowan *et al*., 1993).

Despite being fed 50/50 rolled barley/sorghum in their PMR for a 4 week adjustment period prior to commencement of the first experimental period, milk yield of cows then fed sorghum were lower than for cows in treatments offered barley. Faecal starch levels of 14.1, 18.3 and 17.4% respectively in each period, compared with 1.9, 1.2 and 1.7% for cows offered equivalent levels of barley reveal that the sorghum was less effectively utilised. Davison *et al*., (1994) measured similar faecal starch levels for cows fed rolled sorghum based concentrates. Although faecal starch levels for cows fed barley were quite low, they were highest for period 1. This may reflect a period of adaptation to twice daily feeding as they had previously been fed concentrates as part of a PMR (feed pad ration) consumed over a 7-8 hour period.

Low initial milk yield responses to increased level of concentrate supplementation have been shown in other short duration studies (Davison and Elliott. 1993). Despite the short duration of the experiment, the milk yield response of 0.9 litre milk/kg grain (as barley) in period 3 approached levels expected in long term studies (Davison and Elliott, 1993). The increasing response may reflect a response to reducing quality of forage eaten or some adaptation to the increased grain diet. Carry-over effects could further enhance this response but were not examined in this study. Low milk protein percent in summer is a common problem for Holstein-Friesian herds in the subtropics and tropics (G.D. Chopping, pers.com.). Increasing the level of concentrate to cows in summer in our study was ineffectual in improving milk protein content for cows already receiving 6 kg concentrate. Although protein and energy contents of lucerne hay were higher than for the tropical grass pasture, the difference in ME content was small, and use of CSM in the concentrate ensured that protein was not limiting (Moss *et al*., 1992). Extra supplementation as hay instead of grain to maintain forage/grain ratio while increasing nutrient intake was less effective in maintaining milk yield, suggesting high substitution of pasture by lucerne. Pasture intake may not have been sufficiently limited by its availability with 22, 32 and 35 kg green DM and offering a consistent 14-16 kg leaf/cow.day on offer in each period. The increase in pasture DM available in consecutive periods indicates cows could satisfy their appetite for DM, though quality was restrictive.

Reduced production and slow recovery when the grain was changed from barley to sorghum could be a concern for dairy farmers. Producers who mill grain can take advantage of seasonal availability and price differentials for various grains. Our results indicate that dietary changes may impact negatively on cow production responses, reducing the economic advantages. A period of change-over for adaptation to the new grain could be beneficial. Processing of sorghum can improve its utilisation (Davison *et al*., 1994) allowing more rapid response to diet change. Limited response to lucerne hay show that with tropical pasture if pasture is not limiting, grain will be a more effective method of increasing nutrient intake of cows, provided that grain/forage levels do not cause metabolic disturbance or adversely affect milk composition.

ACKNOWLEDGEMENTS

The assistance of Gary Wenzel and Mark O'Dwyer at Mutdapilly for milking and general management of the herd is acknowledged. Sandra Nolan assisted with animal sampling. Peter Martin, Peter van Melzin and Adam Pytko, DPI Animal Research Institute, Yeerongpilly conducted the chemical analyses on pasture, feed and faeces.

REFERENCES

Cowan, R. T., Moss, R. J., Goodwin, P. G. and Fulkerson, W. J. 1998. Efficiency in feeding systems for subtropical dairy production. Anim. Prod. in Aust. 22: 125-128.

Cowan, R. T., Moss, R. J. and Kerr, D. V. 1993. Northern dairy feedbase 2001. 2. Summer feeding systems. Trop. Grasslds. 27: 150-161.

Davison, T. M., Ehrlich, W. K. and Duncalfe, F. 1994. Sorghum grain processing for early and late lactation cows. Proc. Aust. Soc. Anim. Prod. 20: 382.

Davison, T. M. and Elliott, R. 1993. Response of lactating cows to grain-based concentrates in northern Australia. Trop. Grasslds 27: 229-237.

Moss, R. J., Ehrlich, W. K., Martin, P. R. and Mclachlan, B. P. 1992. Response to protein supplementation by dairy cows grazing nitrogen fertilised forages. Proc. Aust. Soc. Anim. Prod. 19: 100-102.

Moss, R. J. and Lowe, K. F. 1993. Development of irrigated forage systems for dairying in subtropical Australia. Proc. 17th Int. Grasslds. Congr. Hamilton NZ/ Rockhampton, Aust: pp1191-1193.

Moss, R. J., Martin, P. R. and Chapman, N.D. 1994. Protein level in concentrates for dairy cows in subtropical pasture systems supplemented with maize silage. Proc. Aust. Soc. Anim. Prod. 20: 124-127.

Northcote, K.H. 1979. A factual key to the recognition of Australian soils. 4th Edn. Rellim Technical Publications: Glenside, SA.

Email:mossr@prose.dpi.qld.gov.au