HIGH MOLASSES DIETS FOR FEEDLOT CATTLE

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SUMMARY

This experiment investigated the effect of high molasses diets on feed intake, growth rate, carcass traits and meat eating quality of *Bos indicus* cross cattle under commercial feedlot conditions. Heifers were allocated to 1 of 3 groups and fed feedlot diets containing 1, 29% or 50% molasses on a DM basis. Average daily DM intake for the first 64 days was 23-24 g/kg liveweight for each of the treatment groups. The inclusion of molasses in the diet reduced (P<0.05) average daily gains (ADG) (control, mid and high molasses groups; 2.1 ± 0.04, 1.7 ± 0.05 and 1.3 ± 0.06 kg/d, respectively). The P8 fat depth was lower (P<0.05) for animals fed the high molasses diet (4.2 ± 0.5 mm) than the control and mid molasses groups (6.9 ± 0.5 and 5.8 ± 0.5 mm, respectively). Objective and subjective measures of meat quality were found to be similar between cattle fed a conventional grain-based diet and medium and high molasses diets. The inclusion of molasses at 29 or 50% (DM basis) in feedlot diets could result in acceptable ADG and produce leaner beef without affecting meat quality.

Keywords: molasses, beef cattle, feedlot, Northern Australia

INTRODUCTION

High molasses diets for cattle were pioneered in Cuba in the 1960s (Preston *et al*. 1967). In northern Australia, molasses has traditionally been seen as an energy supplement, and a medium for delivering non-protein nitrogen. Although molasses is a palatable energy-dense feedstuff (11 MJ metabolisable energy/kg DM) with potential to form the basis of high production diets in feedlots near sugar cane growing areas, it is currently fed at low levels (<10%) in grain-based feedlot diets. The inclusion of molasses at high levels (60% DM basis) in feedlot diets resulted in gains of 1.6 kg/d when fed to housed Brahman steers (Hunter 2000). Molasses is generally a cheaper energy source than other energy-dense feeds such as grains (Bortolussi and Hunter 2000). It would be feasible to add 100 kg of liveweight to approximately 1.3 million head of beef cattle if 0.5 million tonnes of molasses were available per year, and constituted 50% (DM basis) of the diet of feedlot cattle (Hunter 2000). This experiment investigated the commercial reality of feeding high molasses diets to feedlot cattle.

MATERIALS AND METHODS

Experimental animals, design and diets

The experiment was conducted at a feedlot in the Brisbane Valley, Queensland. In all, 270 *Bos taurus* x *B. indicus* heifers (mean ± s.e.m. initial liveweight (LW); 325 ± 2.3 kg) were randomly allocated using a 3-way draft to 1 of 3 treatment groups, 1 group per pen. All animals were adapted to a high-grain feedlot diet by feeding a starter diet consisting of barley grain, hay, silage and molasses (Table 1) for 6 days and an intermediate diet consisting of barley grain, bakery waste, silage and molasses for a further 6 days. Three experimental diets that contained 1, 29 or 50% molasses, and 9, 22 or 18% whole cottonseed, respectively, on a DM basis, were fed from day 13 (Table 1). A liquid mineral supplement prepared by the feedlot was included in the experimental diets to satisfy calium, phosphorus and sodium requirements. Diets were offered at a rate to ensure minimum wastage. Mean individual intakes, per pen basis, were estimated throughout the experiment. Liveweight was measured at induction and on days 43, 64 and 85. Eighty-eight control animals and 45 animals from each of the other treatment groups were slaughtered on day 65, when LW was 360-440 kg. Animals that did not reach a commercially determined LW at day 64 were retained until an average LW of 428 ± 5.1 kg was measured on day 86, after which they were slaughtered.

Slaughtering and processing

Heifers were transported by road (<2h), held for 14-16 h in lairage, and slaughtered in their separate treatment groups. Electrical stimulation was not applied immediately after exsanguination. In the first slaughter (at day 65), carcass characteristics (carcass weight, P8 fat depth, eye muscle area (EMA) and subcutaneous fat colour at slaughter) were recorded for all animals. Eighteen, 20 and 19 carcasses were randomly sampled from the control, mid and high molasses groups, respectively, to measure objective and subjective determinants of meat quality. Carcass pH and temperature decline were also measured over a 10 h period. From each carcass, 1 *M. longissimus dorsi* (LD) was boned-out 24 h post-slaughter, and separated into cranial and caudal sections. Individual sections were vacuum packed and held at –0.5°C for 5 h. Caudal and cranial sections were transported directly to Meat Standards Australia (MSA, Armidale, NSW) or Food Science Australia (FSA, Cannon Hill, Qld), respectively. All samples were aged for 7 d and stored frozen at -20°C before determination of subjective meat quality by MSA, and objective determination of meat quality by FSA. In the second slaughter (at day 86), carcass traits (carcass weight, P8 fat depth, EMA and subcutaneous fat colour at slaughter) were recorded for all animals.

Table 1. Composition of feedlot diets offered to Brahman cross heifers (% total diet DM).

Component of diet	Starter	Intermediate	Control	Mid Molasses	High Molasses
Barley grain	43.0	30.0	47.5	38.0	-
Cane molasses	12.0	10.0	1.0	29.0	50.0
Whole Cotton seed	7.0	7.5	9.0	22.0	18.0
Cotton seed meal	1.5	1.5	-	-	5.0
Lucerne hay	20.0	8.5	-	3.0	19.0
Blended oils	-	1.0	2.0	-	-
Silage	10.0	10.0	8.5	-	-
Bakery waste	-	25.0	25.0	-	-
Dry starter supplement	6.5	3.0	-		
Liquid mineral supplement	-	3.5	7.0	8.0	8.0

Measurements of meat quality

Cranial portions of LD were used to determine objective measures of meat quality after being cooked in a water bath for 60 mins at 70°C. Analyses included Warner-Bratzler shear force, compression, moisture (Harris and Shorthose 1991), minolta colour (L*, a*, b*) and intramuscular fat content. Caudal sections were used for subjective determination of flavour, tenderness and juiciness to determine meat quality scores (MQ4) for each group by MSA taste panels (Polkinghorne *et al.* 1999).

Statistical analyses

Analysis of variance, using the general linear models (GLM) procedure of SAS (1996) with Duncan's multiple range test was used to determine significant differences ($P<0.05$) between treatment means within slaughter groups. Where valid, initial and carcass weights were used as covariates for analysis of productivity and objective meat quality measures, respectively. Animals weighing less than 370 kg at day 85 were retained by the feedlot and excluded from statistical analysis.

RESULTS

Average daily intakes for each treatment group were 23-24 g/kg LW for the first 64 d. Linear regression analysis indicated that mean (± s.e.m.) daily gains were 2.1 ± 0.04, 1.7 ± 0.05 and 1.3 ± 0.06 kg for the control, mid and high molasses groups over 64 d, respectively (Figure 1), which were significantly different (Table 2). Average daily gains were not different for the mid and high molasses-fed animals that were carried over to 85 days (Table 2). The LW measured on day 64 of the high molasses fed animals was significantly ($P<0.05$) less than those achieved by the control and mid molasses fed animals (Table 2). Nine and 10 animals from the mid and high molasses groups, respectively, did not reach the specified slaughter weight within 85 days.

The P8 fat depth was greater for animals fed the control and mid molasses diets compared with the high molasses diet for animals slaughtered after 64 days (Table 3), but there was no significant difference between the mid and high molasses fed animals slaughtered on day 86 (Table 3). Final carcass pH was similar across treatments ranging from 5.5 to 5.6. Eye muscle area was greater for high molasses-fed heifers than for the control group (Table 3) after covariate adjustment using carcass weight. Meat colour (L*, a*, b*), initial yield, peak force and compression were similar between treatment groups slaughtered on day 65. High molasses-fed animals had a significantly higher moisture and lower intramuscular fat content than the control or mid molasses groups (Table 3).

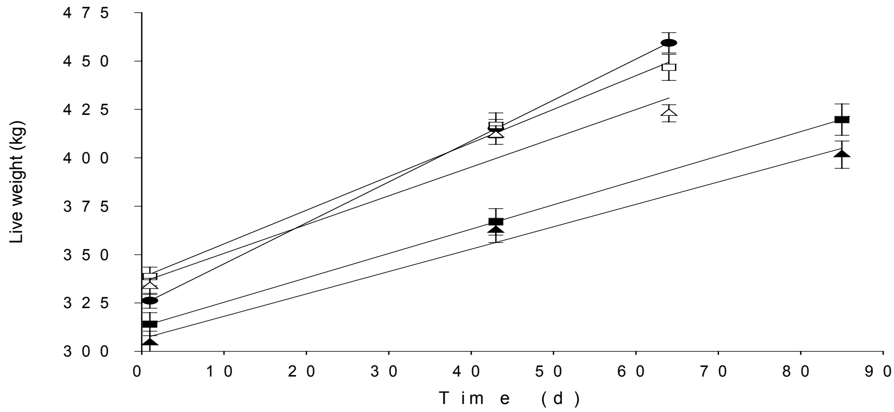

Figure 1. Mean (± s.e.m.) liveweight from induction to day 85. Lines of best fit determined by linear regression analysis are shown for; ● control; □ mid molasses to day 64; ■ mid molasses to day 85; Δ high molasses to day 64; ▲ high molasses diet to day 85. Table 2 summarises liveweight gain results.

Table 2. Productivity of Brahman crossbred heifers fed diets varying in molasses content (least squares means ± s.e.m.).

	Animals slaughtered after 64 days			Animals slaughtered after 85 days	
	Control	Mid molasses	High molasses	Mid molasses	High molasses
Number	88	45	45	36	32
Initial weight (kg)	326 ± 4	337 ± 4	333 ± 4	322 ± 5.9	310 ± 6.8
Daily gain (kg/d)[A]	2.1 ± 0.04[a]	1.7 ± 0.05[b]	1.3 ± 0.06[c]	1.3 ± 0.07	1.2 ± 0.06
DM intake (g/kg W/d)[B]	23	23	24	26	28
Final weight (kg)[A]	464 ± 3[a]	438 ± 4[b]	417 ± 4[c]	433 ± 5	421 ± 6

[A] Data adjusted by covariance analysis for initial weight.
[B] Intake of experimental diets from either days 13-64 or 13-85.
Means in the same row with different superscripts are significantly different ($P<0.05$)

Table 3. The effects of molasses feeding on carcass characteristics of Brahman cross heifers and objective and subjective measurements of meat quality of the *M. longissimus dorsi* after 64 or 85 days (least squares means ± s.e.m.).

		Animals slaughtered after 64 days			Animals slaughtered after 85 days	
		Control	Mid molasses	High molasses	Mid molasses	High molasses
Number		18	20	19	36	32
Hot carcass weight (kg)		241 ± 1.6[a]	227 ± 2.4[b]	215 ± 2.3[c]	226 ± 3.2	213 ± 3.5
Dressing percentage		52 ± 0.2	52 ± 0.3	52 ± 0.3	52 ± 0.4[a]	51 ± 0.4[b]
P8 fat depth (mm)		6.9 ± 0.5[a]	5.8 ± 0.5[a]	4.2 ± 0.5[b]	4.7 ± 0.3	5.3 ± 0.4
EMA[A] (cm^2)		65 ± 1.7[a]	67 ± 1.5[ab]	72 ± 1.6[b]	65.1 ± 0.9	66.3 ± 1.0
Fat colour (subcutaneous)[B]		2.3 ± 0.2	2.6 ± 0.1	2.6 ± 0.2	2.1 ± 0.1	2.4 ± 0.2
Meat colour[C]	L*	40.9 ± 0.5	40.8 ± 0.5	40.3 ± 0.5		
	*a**	22.4 ± 0.4	22.8 ± 0.4	22.3 ± 0.4		
	*b**	10.2 ± 0.2	10.4 ± 0.2	10.1 ± 0.2		
Peak force (kg)		4.6 ± 0.1	4.5 ± 0.1	4.4 ± 0.1		
Initial yield (kg)		3.6 ± 0.1	3.3 ± 0.1	3.4 ± 0.1		
PFIY[D] (kg)		1.0 ± 0.1	1.2 ± 0.1	1.0 ± 0.1		
Compression (kg)		1.8 ± 0.1	1.9 ± 0.1	1.9 ± 0.1		
Moisture (%)		76 ± 0.2[a]	76 ± 0.1[a]	77 ± 0.1[b]		
Intramuscular Fat (%)		1.5 ± 0.1[a]	1.4 ± 0.1[a]	0.8 ± 0.1[b]		
Tenderness[E]		44 ± 3.0	45 ± 2.8	47 ± 2.9		
Juiciness[E]		48 ± 2.7	54 ± 2.6	49 ± 2.6		
Flavour[E]		50 ± 2.6	54 ± 2.5	47 ± 2.6		
MQ4 score[E]		46 ±2.6	49 ± 2.5	47 ± 2.5		

[A] Eye muscle area
[B] USDA fat colour standards
[C] Minolta colour system
[D] Difference between peak force and initial yield
[E] MSA clipped data
Hot carcass weight, dressing % and EMA data adjusted by covariance analysis
Means in the same row with different superscripts are significantly different (P<0.05)

DISCUSSION

This experiment demonstrated that liveweight gains greater than 1 kg/d can be achieved when high molasses diets are fed. The results validated those previously obtained in animal house experiments when cattle fed 45-60% molasses in a complete diet gained over 1.2 kg/d, had commercially acceptable carcass traits, and provided striploins of guaranteed eating quality (Hunter 2000). In the present experiment, the liveweight gain of approximately 1.3 kg/d on the high molasses diet was likely to be an underestimate of what could have been achieved had heifers been adapted to a high molasses diet. The logistics of the commercial feedlot dictated that all heifers were adapted to cereal grain feeding. Heifers in the molasses groups encountered substantial amounts of molasses for the first time when the experimental diets were fed. Consequently, animals on the high molasses diet went through a further adaptation for up to 9 days involving reduced intakes (approximately 15.3 g/kg LW per day). Calculated metabolisable energy intakes from days 43 to 64 for heifers fed the high molasses diet and slaughtered at day 65 averaged 119 MJ/d and would be expected to have resulted in an ADG of 1.3 kg/d. However, the aberration in liveweights (Figure 1) that contributed to an underestimate of ADG for these animals could not be explained in terms of recorded feed intakes. While these animals had an ADG of less than 1.0 kg/d, medium mature size heifers weighing 400 kg could be expected to gain 1.25 kg/d with a metabolisable energy intake of 108 MJ/d (ARC 1980). There were no indications of molasses toxicity, laminitis or digestive upsets in these animals. At both slaughter times, animals were transported, held in lairage and processed as separate treatment groups. This resulted in a confounding of time of kill with carcass traits. The reduction in P8 fat depth associated with the high molasses diet in this experiment was similar to results previously reported with high molasses diets (Hunter 2000).

Results indicated that the inclusion of molasses at 29 or 50% (DM basis) in a feedlot diet has the potential to produce lean beef without affecting meat quality. This information is important at times of high grain prices, as it allows feedlot managers to formulate diets with a reduced feed cost per unit liveweight gain. High molasses diets are potentially useful for the beef feedlot industry and could be used to assure consistency of supply of cattle to the live export trade. The technology is not a replacement for conventional grain in all feedlots, but is seen as a viable strategy in northern Australia, particularly in areas close to sugar mills, and feedlots targeting premium export beef markets.

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