EFFECT OF GROWTH RATE ON MEAT QUALITY OF BEEF CATTLE

B.L McIntyre, Department of Agriculture, Baron-Hay Court, South Perth, Western Australia

SUMMARY

Thirty three steers approximately 14 months of age and weighing 245 kg were allocated to three growth rate treatments. Diets were manipulated so that cattle would lose (L treatment) maintain (M treatment) or gain (G treatment) weight for 26 days prior to slaughter but have similar carcass weight and fatness at slaughter. All carcasses were electrically stimulated and samples of *M. longissimus thoracis et lumborum* removed for meat quality evaluation. There were no significant (P)0.05) differences in shear force, adhesion or taste panel score among the growth rate treatments. Muscle pH was significantly (P < 0.05) lower for the G treatment than for the M treatment and meat colour score was significantly (P < 0.05) lighter for the G treatment than for both the L and M treatments. It was concluded that growth rate immediately prior to slaughter had no effect on meat tenderness but may have a small effect on meat colour.

INTRODUCTION

In many areas of Australia losses in liveweight of cattle are an inevitable consequence of seasonal fluctuations in quantity and quality of available feed. This nutritional stress plus seasonal fluctuations in prices can lead to the sale of cattle after a period when their live weight is maintained or decreasing. It is generally believed that meat from rapidly growing cattle has better eating quality than meat from cattle which have grown slowly or lost weight (Shorthose 1976). The scientific evidence on this question is somewhat contradictory. Aberle et al. (1981) and Fishell et al. (1985) found improvements in meat tenderness associated with higher planes of nutrition and more rapid growth rate. McKeith et al. (1985) also reported that tenderness improved with increases in the time animals were fed on high concentrate diets. Cattle in these studies had all been growing actively. By contrast Murray (1970) and Crouse et al. (1986) found no difference in tenderness of meat from cattle that had maintained or lost weight before slaughter and those which had grown rapidly. Moody (1976) in reviewing a number of studies concluded that within limits, tenderness and other palatability traits were little affected by differences in nutritional plane.

In some studies the effect of nutritional plane has been confounded by differences in carcass weight and fatness. These factors influence the rate at which carcasses chill, which in turn can effect the extent of cold toughening. Bowling et al. (1977) suggested that fatness may have a direct influence on meat quality apart from its effect on rate of chilling.

The aim of this experiment was to determine the influence of varying growth rate on the quality of meat from cattle slaughtered at similar weight and fatness.

EXPERIMENTAL METHODS

Thirty three Kimberley Shorthorn steers approximately 14 months of age and 245 kg liveweight were used in this experiment. On day 1 of the experiment the steers were individually identified, treated for internal parasites, weighed and allocated from within weight strata to one of three feeding regimes. These feeding regimes were designed so that the cattle would lose weight (L), maintain weight (M) or gain weight (G) for 26 days before slaughter but have the same weight and fatness at slaughter.

The diets used for the three regimes were as follows :-

(a) A concentrate ration of hay (52.3%), lupin grain (20.3%), oat grain (25.3%), urea (1.3%) and mineral supplement (0.8%) available ad libitum.

(b) Summer-Autumn pasture. This consisted of abundant dry material which became progressively weathered over time. A limited amount of green new seasons pasture was available towards the end of the experiment.

(c) Oaten hay fed at 5 kg per head per day.

The treatments were managed as follows :-

L: Days 1-111 concentrate ration; days 112-137 pasture.

Table 1. Live and carcase characteristics of cattle subjected to L,M and G growth rates prior to slaughter.

	Growth rate		
	L	M	G
Live weight change final 26 days (kg)	-32.6	-23.8	26.2
Final live weight (Kg)	323.7	313.8	352.9
Cold carcase weight (kg)	177.9	168.3	181.0
Dressing percent	55.0	53.6	51.3
Fat Thickness (mm)	3.3	2.3	4.5

Table 2. Meat quality characteristics of M. longissimus thoracis et lumborum of cattle subjected to L, M and G growth rates prior to slaughter.

	Growth rate		
	L	M	G
Shear force(kg)	3.45	3.65	3.32
Adhesion(kg)	0.58	0.65	0.66
Taste panel score[1]	3.52	3.24	3.38
Muscle pH	5.66[ab]	5.69[b]	5.62[a]
Meat colour score[2]	3.91[b]	4.10[b]	3.55[a]

1 Taste panel scores range from 1 (very tough) to 6 (very tender).

2 Meat colour scores range from 1 (extremely light red) to 6 (extremely dark)

a and b where present, indicate significant (P<0.05) differences between means for growth rate treatments.

M: Days 1-28 pasture; days 29-111 concentrate ration; days 112-137 pasture and oaten hay.

G: Days 1-55 pasture; days 56-137 concentrate ration.

All animals were weighed immediately off feed at approximately 2 weekly intervals to monitor their progress on the anticipated growth path. Fatness was assessed to determine when feeding of the concentrate ration to the L and M treatments should cease. It was proposed that at slaughter, all animals should have a fat thickness of 5-7 mm over the eye muscle between the 12 th and 13 th ribs. On day 138 all cattle were weighed and transported to the abattoir for slaughter the next day. (One animal from the M treatment died during the experiment but the cause was not related to the treatments).

Fat thickness was measured on the hot carcass and carcass weight was recorded the day after slaughter. Each carcass was electrically stimulated (800 volts RMS half sinusoid; 14.3 pulses per sec) for 2 minutes within 45 minutes of slaughter.

On the day following slaughter the section of M. longissimus thoracis et lumborum between the 10 th and 11 th thoracic vertebrae and the 3 rd and 4 th lumbar vertebrae was removed from one side of each carcass. These samples were vacuum packaged, frozen and stored at -18°C prior to meat quality assessments. Meat quality assessments of shear force, adhesion, taste panel tenderness, muscle pH and meat colour were made as described by McIntyre and Ryan (1984).

Analysis of variance was used to compare the effects of pre slaughter growth rate.

RESULTS

The live weights of the cattle in the three treatments are shown in Figure 1. Cattle in the G treatment gained more weight in the 2 weeks before they commenced concentrate feeding and those in the M treatment lost slightly more during the final 26 days than was planned (Table 1). Although the cattle in the G treatment were 30 and 40 kg heavier than those in the L and M treatments, the large differences in dressing percentage resulted in carcass weights differing by only 3 and 13 kg respectively.

Fat thickness ranged from 2.3 mm (L treatment) to 4.5 mm (G treatment) and measurements for all treatments were below those planned.

There were no significant ($P>0.05$) differences among growth rate treatments for shear force, adhesion or taste panel score (Table 2). Cattle from the G treatment had a lower muscle pH than those in the M treatment and lighter meat colour than those in the L and M treatments.

DISCUSSION

The results of this experiment indicate that cattle can undergo a period of relatively severe nutritional stress immediately prior to slaughter without any adverse effect on the tenderness of the meat. The losses in liveweight of 33 kg and 24 kg in the L and M treatments respectively during the last 26 days contrasts strongly with the gain of 26 kg for the G treatment. The higher dressing percentages of the L and M treatments indicate that a substantial proportion of their liveweight loss was due to reduced gut content. The carcass weight loss for the animals in the L treatment was estimated to be about 5 kg on the assumption that they had a similar dressing percentage at the start of the final 26 days as those of the G treatment at slaughter (51.3%). Assuming a lower dressing percentage (50%) at the start of the final 26 days for the lighter, leaner animals in the M and G treatments, their changes in carcass weight were estimated to be -0.5 kg and 17.5 kg respectively. Similarly, changes in fatness during the final 26 day period cannot be determined accurately. Subjective assessments indicated losses in fatness for both the L and M treatments and increases for the G treatment.

The results for the meat tenderness characteristics support those of Crouse et al. (1986) who reported that neither time on feed nor rate of growth had a significant effect on the

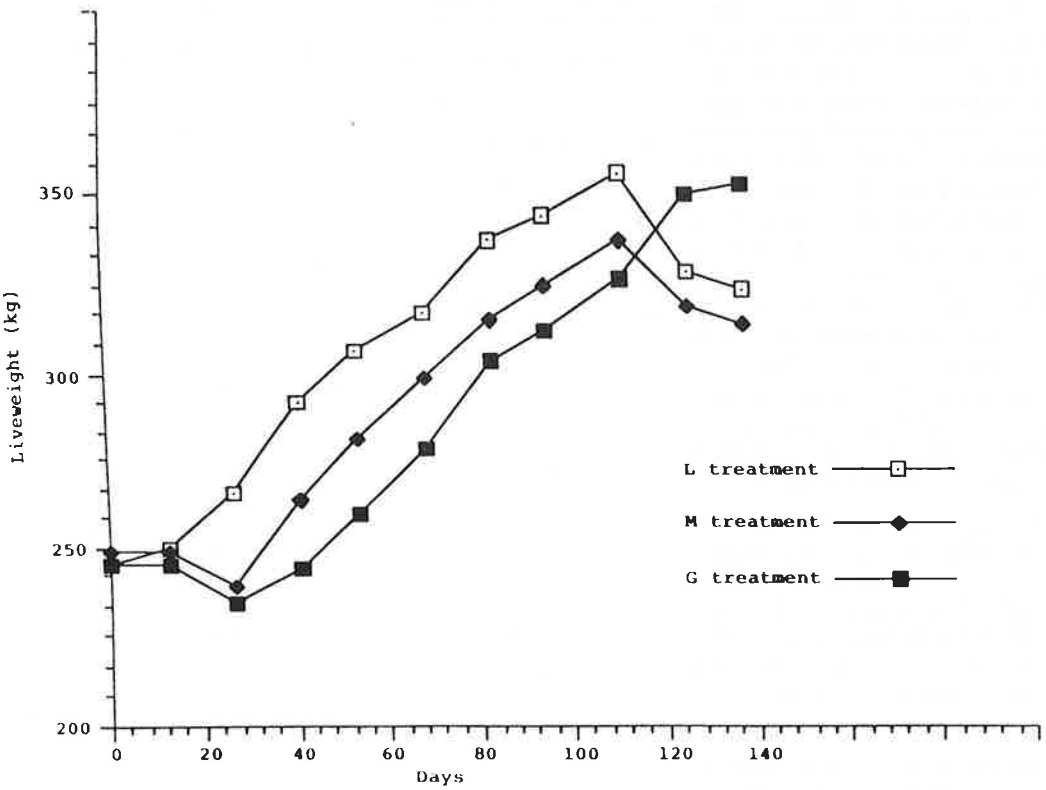

Figure 1. Liveweight changes of cattle subjected to L, M and G growth rate treatments prior to slaughter

tenderness of meat from cattle which had been gaining, maintaining or losing weight for 30 or 60 days prior to slaughter. Murray (1970) also found no difference in meat quality between cattle that had gained or maintained weight for various times before slaughter. The results conflict with those of Aberle et al. (1981) and Fishell et al. (1986) who reported improvements in tenderness associated with higher growth rate. This was attributed in part to differences in the connective tissue. In both studies meat from faster growing animals had a higher percentage of soluble collagen which indicated an increased rate of collagen turnover and the formation of fewer intermolecular crosslinks. In the present study the adhesion values indicated no differences in connective tissue strength. Similarly, in the study by Crouse et al. (1986) no differences in the solubility of collagen were found.

It is possible that the effects attributed to growth rate by Aberle et al. (1981) and Fishell et al. (1986) were due to fatness, since in both studies increasing growth rate was accompanied by large increases in carcass fatness. The effect of fatness in reducing the rate of chilling of the carcass and thereby reducing cold toughening is well recognized (Smith et al. 1976; Bowling et al. 1977; Lochner et al. 1980). Aberle et al. (1981) considered an effect of chilling rate was unlikely since no differences in sarcomere length were found. In the study by Fishell et al. (1986) the rate of chilling was closely controlled so that the carcasses from slowly growing animals actually cooled more slowly than those from fatter rapidly growing ones. Despite this sarcomere length was shorter in the animals grown more slowly. Bowling et al. (1977) has also suggested a possible link between fatness and increased activity of proteolytic enzymes leading to improved tenderness. In the present study and in that of Crouse et al. (1986) differences in fatness of animals in the various growth rate treatments were much lower than those in the above studies. The possibility of an effect of fatness due to either cold toughening (prevented in this study by the use of electrical stimulation) or increased rate of enzyme activity is therefore greatly reduced.

The small but significant ($P < 0.05$) differences in muscle pH and meat colour may be a direct effect of the degree of nutritional stress imposed on the animals. However adverse weather conditions in the form of rain and wind on the day the animals were transported and the mixing of the three treatment groups for transport may have been involved. Nutritional, climatic and emotional stress have been identified as factors which can result in high ultimate pH and dark cutting meat and these effects are thought to be cumulative (Grandin 1980; Hedrick 1981; Wythes and Shorthose 1984). The higher muscle pH and darker colour of meat from animals on the L and M treatments may be an indirect reflection of a reduced ability to tolerate the climatic and emotional stresses during the final stages of the experiment. Whatever the causal mechanism pre slaughter growth rate could have some implications for the acceptability of the meat.

REFERENCES

Aberle, E.D., Reeves, E.S., Judge, M.D., Hunsley, R.E. and Perry, T.W. (1981). *J. Anim. Sci.* **52**:757.

Bowling, R.A., Smith, G.C., Carpenter, Z.L., Dutson, T.R.and Oliver, W.M. (1977). *J. Anim. Sci.* **45**:209.

Crouse, J.D., Calkins, C.R. and Seideman, S.C. (1986). *J. Anim. Sci.* **63**:1824.

Fishell, V.K., Aberle, E.D., Judge, M.D. and Perry, T.W. (1985). *J. Anim. Sci.* **61**:151.

Grandin, T. (1980). *Int. J. Stud. Anim. Prob.* **1**:313.

Hedrick, H.B. (1981). *In:* The problem of dark-cutting in beef (Hood, D.E. and Tarrant, P.V. Eds), Martinus Nijhoff Publishers, The Hague, p.213.

Lochner, J.V., Kauffman, R.G. and Marsh, B.B. (1980). *Meat Sci.* **4**:227.

McIntyre, B.L. and Ryan, W.J. (1984). *Proc. Aust. Soc. Anim. Prod.* **15**:468.

McKeith, F.K., Savell, J.W., Smith, G.C., Dutson, T.R. and Carpenter, Z.L. (1985). *Meat Sci.* **13**:151.

Moody, W.G. (1976). *Proc. Recip. Meat Conf.* **29**:128.

Murray, D.M. (1970). *Proc. Aust. Soc. Anim. Prod.* **8**:226.

Shorthose, W.R. (1976). Proc. Third Interstate Refresher Course on Beef Cattle Production, Qld Agric. College, Gatton, June 1976, p.57.

Smith, G.C., Dutson, T.R., Hostetler, R.L. and Carpenter, Z.L. (1976). *J. Food Sci.* **41**:748.

Wythes, J.R. and Shorthose, W.R. (1984). A.M.R.C. Review No.46.