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Growth and carcass characteristics of Wagyu-sired steers at heavy market weights following slow or rapid growth to weaning

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Abstract. Two groups of Wagyu × Hereford steers grown slowly (slow preweaning group, $n = 14$, mean average daily gain = 631 g/day) or rapidly (rapid preweaning group, $n = 15$, mean average daily gain = 979 g/day) from birth to weaning were backgrounded on improved, temperate pasture to equivalent group liveweights (543 *v.* 548 kg, s.e. = 8.8 kg), then finished in a feedlot for 120 days. At weaning, the slow preweaning group was 79 kg lighter than the rapid preweaning group. They required an additional 43 days of backgrounding to reach the same feedlot entry weight as the rapid preweaning group. The slow preweaning group grew more rapidly during backgrounding (630 *v.* 549 g/day, s.e. = 13.7 g/day) but tended to grow more slowly during feedlotting (1798 *v.* 1982 g/day, s.e. = 74.9 g/day) than their rapid preweaning counterparts, with overall growth rates from weaning to feedlot exit not differing between the 2 groups (rapid 763 g/day *v.* slow 772 g/day, s.e. = 17.5 g/day). At slaughter, following the feedlot phase, carcass weights of the 2 groups did not differ significantly (rapid 430 kg *v.* slow 417 kg, s.e. = 7.2 kg). There was a tendency for the steers grown slowly to weaning to have a higher dressing percentage (57.6 *v.* 56.6%, s.e. = 0.33%), but there were no significant differences in carcass compositional characteristics between the 2 groups. The slow preweaning steers did have a greater eye muscle area than the rapid preweaning steers (106.6 *v.* 98.9 cm^2, s.e. = 1.87) when carcass weight was used as a covariate. These findings demonstrate that cattle grown slowly to weaning have similar composition at slaughter as those grown rapidly during the same period when backgrounded on pasture to the same feedlot entry weight. Furthermore, marbling was not adversely affected by slow growth to weaning.

Additional keywords: backgrounding, beef, cattle, feedlot, marbling, meat.

Introduction

Previous research has demonstrated that, although cattle restricted in growth early in life take longer to achieve target weights, the effects on body composition at equivalent age or carcass weights are minimal within pasture-based feeding systems postweaning (Hearnshaw 1997; Tudor *et al*. 1980) or following backgrounding on pasture combined with feedlot finishing (Greenwood *et al*. 2006; Hearnshaw 1997). However, the heavy market weight cattle that underwent divergent growth to weaning in the study of Greenwood *et al*. (2006) entered the feedlot and were slaughtered at an equivalent age on the same day in order to eliminate confounding on characteristics relating to beef eating quality due to day of kill effects. In these cattle there was considerable variation in feedlot entry weight between groups of animals due to divergent early-life growth rates. Hence, there is a need to confirm the results of the effects of growth early in life in cattle backgrounded to equivalent feedlot entry weights and feedlot finished to heavy market weights. This is particularly important for cattle destined for markets such as Japan that specify high levels of marbling.

The objective of this current study was to determine the impact of growth restriction early in life on postweaning growth, and on subsequent carcass characteristics when steers grown slowly or rapidly to weaning entered the feedlot at an equivalent liveweight. To achieve this objective, selected groups of Wagyu-sired steers from the study of Cafe *et al*. (2006) grown slowly or rapidly to weaning were backgrounded on pasture in a common environment to an equivalent feedlot entry weight and feedlot finished to export carcass specifications.

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Materials and methods

Experimental design

The animals used in this study were produced as part of the research project described by Cafe *et al*. (2006) that studied effects of nutrition early in life on calf birth weight and growth to weaning. The research was conducted at the NSW Department of Primary Industries Grafton Agricultural Research and Advisory Station. Fifteen Wagyu × Hereford steers grown slowly to weaning and with low weaning liveweights (slow preweaning group) and 15 Wagyu × Hereford steers grown rapidly to weaning and with high weaning liveweights (rapid preweaning group) were selected for study. Seven Wagyu sires were represented in the study, with the treatment groups selected to avoid bias due to sire. Detail of the management of the cows and calves from mating to weaning is described by Cafe *et al*. (2006). The selected steers were born between August and November 2002. The growth of the 2 groups to weaning is shown in Table 1.

Backgrounding

Soon after weaning in April 2003, the steers were transported 150 km from Grafton to the NSW Department of Primary Industries Centre for Perennial Grazing Systems at Glen Innes, where they were backgrounded on good quality temperate pastures. The steers grazed as a single herd until mid-October 2004, when the groups were separated prior to the rapid preweaning group leaving Glen Innes in late-October 2004, at the end of their backgrounding period. The slow preweaning group remained on pasture at Glen Innes until their average liveweight matched that of the rapid preweaning group at the end of backgrounding, which occurred in December 2004. The growth characteristics of the 2 groups during backgrounding are presented in Tables 1 and 2. Measurements were not made of pasture on offer during backgrounding, although a detailed description of the species present and the typical yearly pattern of pasture growth on the research station are provided by Ayres *et al*. (2001).

Feedlotting

At the end of their respective backgrounding periods, both groups were transported 290 km to Yarranbrook Feedlot at Inglewood, Qld. At induction they were weighed, drenched for internal parasites (Panacur, Intervet Pty Ltd, Bendigo East, Vic.), implanted with a growth promotant (Synovex Plus, Fort Dodge Animal Health, Baulkham Hills, NSW), vaccinated for clostridial diseases (5 in 1) and given an injection of vitamins A, D and E. Both groups were assessed for body composition at feedlot entry by the same operator using a real-time ultrasound scanner (3.5 MHZ/180 mm linear array animal science probe, Esaote Pie Medical, Maastricht, The Netherlands). The cross-sectional area of the eye muscle, fat depths at the P8 rump and 12th/13th rib sites, and the intramuscular fat percentage in the eye muscle were assessed.

The steers were fed a grain-based diet for a period of 120 days. The diet for both groups was formulated to be 769 g dry matter (DM)/kg, 135 g crude protein (CP)/kg DM, 12.2 MJ metabolisable energy (ME)/kg DM and 205 g neutral detergent fibre (NDF)/kg DM. The feeding period for the 2 groups overlapped by 74 days, or about 60% of their duration in the feedlot. During the feedlot period, 1 animal from the slow preweaning group died of an unknown cause, hence, its growth data were excluded from the results.

Slaughter and carcass measurements

The rapid preweaning group was slaughtered in February 2005, and the slow preweaning group in April 2005. Both groups were weighed prior to being transported 108 km to John Dee Abattoir, Warwick, Qld on the day prior to slaughter. At slaughter, standard carcasses were prepared, split longitudinally into 2 sides, hot weight and rump (P8) fat measured, and a VIAscan image taken of each side before chilling. Following quartering at the 10th/11th rib on the next morning, the carcasses underwent chiller assessment using MSA (MSA 1999) and VIAscan (Ferguson *et al*. 1995) procedures.

Statistical analysis

Results were analysed using 1-way analysis of variance, with growth to weaning (rapid or slow preweaning group) as the only factor in the model. The effect of birth weight was tested as a covariate for the growth and carcass traits, but was not significant in any of the models and was, therefore, excluded from the analyses. Where significant, linear and quadratic terms for carcass weight were also used as covariates to assess effects of preweaning growth on carcass characteristics. Significance of effects was accepted at $P<0.05$ and a tendency towards significance at $0.05<P<0.10$.

Results

Growth characteristics

There was a 79-kg difference in liveweight between the 2 preweaning growth groups at weaning, due to the rapid

Table 1. Growth characteristics of Wagyu × Hereford steers from birth to weaning (200 days of age) and during common backgrounding (541 days from April 2003 to September 2004) when grown slowly or rapidly to weaning

ADG, average daily gain; LW, liveweight

	Slow group ($n=14$)	Rapid group ($n=15$)	s.e.d.	*P*-value
Birth to weaning ADG (g/day)	631	979	27.0	<0.001
Birth to weaning LW gain (kg)	125	202	8.5	<0.001
Weaning weight (kg)	157	236	8.5	<0.001
Common backgrounding ADG (g/day)	602	568	18.8	0.08
LW at end of common backgrounding (kg)	483	543	10.5	<0.001

Table 2. Growth characteristics of Wagyu × Hereford steers grown slowly or rapidly to weaning, and backgrounded to equivalent feedlot entry weights

ADG, average daily gain; LW, liveweight

	Slow group ($n=14$)	Rapid group ($n=15$)	s.e.d.	*P*-value
Backgrounding period (days)	611	568	n.a.	n.a.
Backgrounding ADG (g/day)	630	549	19.4	<0.001
Backgrounding LW gain (kg)	385	312	11.6	<0.001
Backgrounding exit LW (kg)	543	548	12.5	0.65
Feedlot ADG (g/day)	1798	1982	105.9	0.09
Feedlot LW gain (kg)	196	222	11.7	0.04
Feedlot exit LW (kg)	724	759	17.2	0.05
Postweaning[A] ADG (g/day)	772	763	24.8	0.74
Postweaning LW gain (kg)	567	523	17.8	0.02

[A]Period from weaning to feedlot exit.

group growing at a rate of 979 g/day compared with 631 g/day for the slow group (s.e. = 19.1 g/day) from birth to weaning (Table 1). Backgrounding growth tended to be greater (by 34 g/day) within the slow preweaning than the rapid preweaning group from weaning to the liveweight at the end of September 2004, which was the last common weight date for the 2 groups. The 2 groups exhibited similar patterns of growth throughout most of the backgrounding period (Fig. 1). Both groups gained weight consistently during backgrounding until May 2004. From May to July 2004 both groups suffered a period of weight loss, followed by very slow growth rates until August 2004. Over this period (May to August) the slow preweaning group lost weight at twice the rate of the rapid preweaning group (−224 *v.* −106 g/day, s.e. = 37.1 g/day). At the end of the common backgrounding period (September 2004), the group grown rapidly to weaning remained 60 kg heavier than the group grown slowly to weaning.

The rapid preweaning group left Glen Innes for the feedlot at the end of October 2004 at an average liveweight of 548 kg (Table 2). The slow preweaning group remained on pasture at Glen Innes for an additional 43 days during which time they grew rapidly (846 g/day, s.e. = 55.9 g/day) after good falls of rain resulted in excellent late spring pasture growth (Fig. 1). The slow preweaning group reached an equivalent end of backgrounding liveweight of 543 kg (Table 2) in December 2004 at which time they were transported to the feedlot.

Ultrasound scans to assess body composition at feedlot induction showed that the slow preweaning group entered the feedlot with a larger eye muscle area (EMA) and a greater depth of rump fat at the P8 site than the rapid preweaning group (Table 3). There were no significant differences in the 12th/13th rib fat depth or in percentage of intramuscular fat between the 2 preweaning growth groups at feedlot entry.

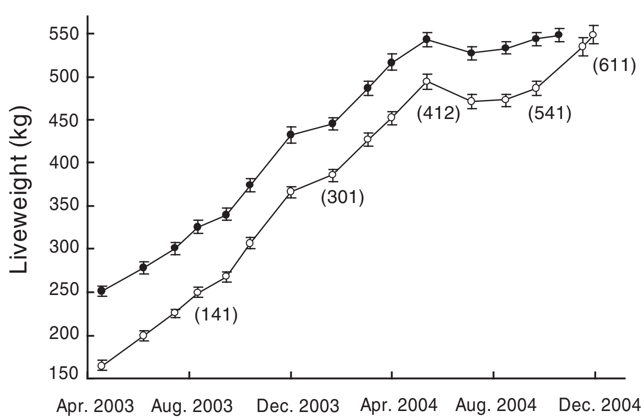

Fig. 1. Liveweight change during pasture backgrounding of steers grown slowly (○) or rapidly (●) to weaning. Values are mean ± s.e. Numbers in parentheses are the number of days of backgrounding growth that had elapsed when liveweights were measured (presented at selected points along the growth curves).

The rapid preweaning group showed a tendency to grow more rapidly (by 184 g/day) in the feedlot than the slow preweaning group and, hence, tended to be heavier (by 35 kg) at feedlot exit (Table 2).

There was no difference between the preweaning growth groups in overall growth rates for the period from weaning to feedlot exit, although the slowly grown group had a greater overall weight gain due to their longer backgrounding period. At slaughter, the slow preweaning group were 39 days older than their rapid preweaning counterparts.

Carcass characteristics

Carcass weight did not differ significantly between the rapidly and slowly grown preweaning groups, although the slow preweaning group tended to have a higher dressing percentage (Table 4). Similarly, yield of meat predicted by

Table 3. Real-time ultrasound scanning measurements of indices of body composition at feedlot entry of Wagyu × Hereford steers grown slowly or rapidly to weaning

	Slow group ($n = 14$)	Rapid group ($n = 15$)	s.e.d.	*P*-value
Eye muscle area (cm^2)	79.5	73.9	1.72	0.003
P8 fat depth (mm)	11.4	9.5	0.92	0.05
Rib fat depth (mm)	7.3	6.7	0.52	0.29
Intramuscular fat (%)	4.64	4.09	0.41	0.19

Table 4. Carcass characteristics of Wagyu × Hereford steers grown slowly or rapidly to weaning, followed by backgrounding to an equivalent feedlot entry weight and 120 days in feedlot

	Slow group ($n = 14$)	Rapid group ($n = 15$)	s.e.d.	*P*-value
Age at slaughter (days)	932	893	7.9	<0.001
Carcass weight (kg)	417	430	10.2	0.21
Dressing percentage	57.6	56.6	0.47	0.06
Hot rump (P8) fat (mm)	26.2	27.2	2.60	0.71
MSA EMA (cm^2)	104.7	100.7	3.78	0.29
MSA rib fat (mm)	13.4	13.0	1.64	0.80
MSA Aus marbling score (0–6)	2.16	1.91	0.431	0.56
MSA ossification score (100–590)	196	197	5.8	0.97
MSA meat colour score (1A-7)[A]	3.15	3.60	0.336	0.20
MSA fat colour score (0–9)	0.14	0.53	0.195	0.06
VIAscan meat yield (%)	68.0	67.3	0.57	0.26
VIAscan meat yield (kg)	275	281	8.1	0.46

[A]MSA meat colour transformed to a numeric scale for analysis. Scale 1–9, where a score of 6 or greater is 'dark'.

VIAscan imaging did not differ due to preweaning growth rate and there were no differences in rump and rib fat depths, marbling score or ossification score at slaughter (Table 4). Meat colour did not differ due to preweaning growth, however there was a tendency for the rapid preweaning group to have a fat colour score indicative of slightly more yellow fat than the slow preweaning group. Where carcass weight was a significant covariate, EMA was significantly greater in the slowly than in the rapidly grown preweaning group (106.6 *v.* 98.9 cm^2, s.e.m. = 1.87 cm^2, $P = 0.008$).

Discussion

The results of this study show that there was little difference in overall growth rates from weaning to feedlot exit or in carcass weight and composition between heavy market weight steers grown slowly or rapidly to weaning that entered the feedlot at the same liveweight.

The cattle grown slowly to weaning showed limited liveweight compensation during backgrounding. During the 18-month period when the groups were backgrounded together, the steers grown slowly to weaning gained 24% of the liveweight difference between the groups at weaning. However, because the seasonal conditions at the end of the backgrounding period were different for the 2 groups, they differed by only 43 days in age at feedlot entry. The rapid preweaning group left Glen Innes in late October, prior to a period of rapid late-spring pasture growth (Ayres *et al*. 2001), and their growth rate for the final 2 months of backgrounding was only 251 g/day. By comparison, the slow preweaning group remained at Glen Innes during the period of rapid late-spring pasture growth, when cattle on the Northern Tablelands typically have high growth rates (Dicker *et al*. 2001), and averaged 846 g/day for the final 2 months of backgrounding.

The difference in growth rates of the 2 groups at the end of backgrounding is likely to have been a major contributor to the higher ultrasound scanned EMA and rump fat of the slow preweaning group at feedlot entry, and to the tendency towards reduced growth of the slow preweaning group in the feedlot, compared with their rapid preweaning counterparts (Drouillard and Kuhl 1999). Both groups of cattle experienced weight loss during winter 2004 and restricted growth until October 2004, when the rapid preweaning group entered the feedlot. The slow preweaning group that remained at Glen Innes longer would have been exhibiting compensatory growth from when the pasture nutrient supply improved in November 2004 until feedlot entry in December 2004. Therefore, it is feasible that the level of compensation in the feedlot of these cattle was reduced compared with the rapid preweaning group which only had access to an adequate nutrient supply to support compensation upon feedlot entry (McLennan 1997).

Results from the present study suggest that the tendency towards different feedlot growth rates between the 2 groups was not specifically related to the growth rate during the preweaning period. The most significant cause for the different feedlot growth rates in this case was the difference in pasture availability the 2 groups were subject to at the end of their respective backgrounding periods. The absence of differences between the 2 groups in overall growth rate from weaning to feedlot exit supports this finding. This is also consistent with the findings from previous studies (Greenwood *et al*. 2006; Hearnshaw 1997; Hennessy *et al.* 2001), where animals restricted in growth prior to weaning grew more rapidly than their better nourished counterparts during pasture backgrounding then more slowly in the feedlot.

The finding that there were no adverse effects on carcass composition in the cattle grown slowly to weaning compared with those grown rapidly to weaning is generally consistent with the findings of Greenwood *et al*. (2006). However, Greenwood *et al*. (2006) studied cattle with more extreme differences in preweaning growth and the cattle grown slowly to weaning were leaner at heavy market weights than those grown rapidly to weaning. The results of the present study are also consistent with the study of Hennessy *et al*. (2001) and with those reviewed by Berge (1991) and Hearnshaw (1997) in which cattle were leaner or of similar composition at market age or weight following restricted growth to weaning than their better nourished counterparts unless grown on high energy concentrate diets for the entire postweaning period (Tudor *et al*. 1980). In the present study and that of Greenwood *et al*. (2006), restricted growth to weaning did not have any deleterious effects on marbling at slaughter.

It is concluded that Wagyu × Hereford steers grown rapidly or slowly to weaning differed little in their growth from weaning to feedlot exit, or in carcass weight and composition following entry into the feedlot at the same liveweight and slaughter at equivalent heavy carcass weights. Furthermore, marbling was not adversely affected by slow growth to weaning.

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