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Effects of post-pubertal castration and diet on growth rate and meat quality of bulls

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ABSTRACT

By castrating bulls post-puberty and then finishing before slaughter it may be possible to obtain both the higher growth rate of bulls but the meat quality of steers. Of 50 crossbred bulls, 20 were castrated at 10 months-of age (steers) and 20 castrated at 17 months-of age (castrates). One month after the latter castration, all animals commenced a 100 day finishing period and were slaughtered at the end. Ten steers and 10 castrates were fed a diet of 50% barley : 50% silage while the rest grazed brassica crop and pasture. Bulls were 20 kg heavier than steers at post-pubertal castration (388 ± 2 vs 365 ± 3 kg, P<0.001) but at slaughter castrates and steers were similar in liveweight and carcass weight, but lighter (P<0.001) than bulls. During finishing, castrates retained the high eye muscle area, but lost the pronounced neck muculature of bulls and were intermediate between bulls and steers in fat depth. Feedlot cattle had whiter fat and lower fat carotenoid concentrations than cattle on pasture. Results indicate that post-pubertal castration of bulls could produce meat with steer characteristics if the interval from castration to slaughter was long enough, but it may be difficult to retain the growth rate and liveweight advantage of bulls after castration.

Keywords: bulls, steers, post-pubertal castration, carcass, meat quality

INTRODUCTION

Over many years, production of bull beef has been an attractive option for farmers. The price paid per kg carcass weight has generally exceeded that of steers, and the lack of grading requirements has ensured relative simplicity in production and marketing. However, this has resulted in the focus on a single market, both geographically and in terms of product characteristics. Recent trends in the beef industry indicate modification of carcass characteristics of animals raised as bulls could expand marketing opportunities (Wright *et al.*, 1993).

Post-pubertal castration of bulls followed by a finishing period as 'steers' may allow both the faster growth rate and more efficient feed conversion of bulls, and also the development of the meat quality attributes of steers. Bulls can grow up to 17% faster than steers, with up to 13% greater feed conversion efficiency (Field, 1971; Arthaud *et al.*, 1977). Compared to steers, meat from bulls has less fat, less marbling, often a higher ultimate pH, a higher incidence of dark cutting meat, and the meat tends to be tougher (Field 1971; Seideman et al., 1982; Purchas 1990). Amelioration of these characteristics would make meat suitable for a wider range of market opportunities, and might also provide the option for farmers to respond to market signals by switching from bull to steer meat production. Most of the yellow colour of beef fat is due to carotenoids (Yang *et al.*, 1992), which tend to be low in silages and grains (Morgan and Everitt 1969). Reducing the carotene intake after castration, when the rate of fat deposition increases, should ensure that carcass fat is whiter.

The objective was to examine liveweight gain and the potential for modification of carcass meat and fat characteristics during a finishing period following post-pubertal castration.

MATERIALS AND METHODS

Friesian-cross bulls, born in spring 1993 at AgResearch Flock House, were allocated to this experiment in June 1994 in groups balanced for breed and mean liveweight (LW). An incomplete factorial design was used to compare diet (feedlot vs pasture) and age of castration (pre-puberty vs post-puberty) effects on growth and carcass development. There were five treatments (n = 10); steers (castrated pre-puberty) and castrates (castrated post-puberty) on the feedlot, and bulls, steers and castrates on pasture.

Castration Treatment: Bulls were castrated pre-puberty (176 ± 5 kg LW) in July 1994, at 10 months-of-age (steers) or post-puberty (388 ± 2 kg LW) in January 1995, at 17 months-of-age (castrates). At each time bulls were castrated surgically under local anaesthetic, and returned to their group immediately following castration.

Diet Treatments: Two treatments (Pasture and Feedlot) were offered, to provide a contrast in carotenoid intake. Feeding treatments commenced on 14 February, one month after the post-pubertal castration. Pasture-fed cattle were offered forage brassica (cv. Wairoa) until 20 April, and then grass-dominant pasture until slaughter. A supplement of approximately 2 kg/hd/day of red clover baleage was offered daily from 17 April. On the feedlot, the low-carotenoid diet consisted of pasture silage (50%) and barley grain (50%). The bulls, castrates and steers on pasture were managed as a single group, as were the steers and castrates on the feedlot. Feed was allocated to maintain similar liveweight gains (LWG) of feedlot and grazing animals. The feeding period lasted for 101 days until slaughter in late May 1995.

Measurements

Unfasted liveweights were recorded at 2-weekly intervals from June 1994 and 24-hour fasted liveweights on 17 January, 14 February and 26 May 1995. Post-slaughter measurements were made on carcass sides after 24 hours in the chiller to assess physical (cross-section area of the *M. longissimis dorsi* (eye muscle), neck muscle (*Splenius*) thickness at maximum point), meat (pH, colour) and fat (depth, colour) characteristics. Eye muscle areas were assessed using a digitiser on tracings taken at the 12/13 rib quartering point. Meat and subcutaneous fat colour were determined using a Minolta chromameter and followed the Commission Internationale de l'Eclairage L, a*, b* colour numeration system (Rigg, 1987). For meat samples the a* value (redness), and for fat, the b* value (yellowness) is presented. Subcutaneous fat samples from over the 12/13th rib were taken and carotenoid concentration measured. Fat percentage in LD muscle samples was determined as described by Smith *et al.* (1995).

Statistical analysis

Treatment means were compared by ANOVA (SAS, PROC GLM). Liveweight and carcass weight were not included as covariates.

RESULTS

Liveweight and liveweight gain

Castration effects: After pre-pubertal castration low LWG persisted for nearly 2 months in both bulls and steers. Only from late-August when LWGs increased did the growth rate of bulls exceed that of steers. By mid-January 1995, just prior to post-pubertal castration, bulls were approximately 20 kg heavier than steers, having grown at 1.08 ± 0.1 kg/hd/day compared with 0.96 ± 0.02 kg/hd/day for steers, over 180 days from 20 July ($P<0.001$).

Over the 29 days following post-pubertal castration, LWG for castrates was 0.07 ± 0.06 kg/hd/day, compared with 0.60 ± 0.06 kg/hd/day for bulls and 0.54 ± 0.05 kg/hd/day for steers. At the end of this period the unfasted and fasted LW of the castrates was lower ($P<0.001$) than that of the bulls, but still higher ($P<0.05$) than that of the steers.

Diet effects: Steers and castrates on the feedlot grew faster than similar animals grazing on the pasture (Table 1). On both diets steers continued to grow faster than castrates, although this difference was significant only for the pasture animals. Bulls grew faster than steers on the pasture ($P<0.01$). These effects of castration and diet on LWG were reflected in fasted LWs recorded at the end of the trial. Steers on feedlot or pasture did not differ, but castrates on pasture (436 ± 7 kg) were lighter than castrates on the feedlot (462 ± 7 kg).

Carcass weight and dressing percentage

At the end of the finishing period castrates and steers produced carcasses of similar weight on both diets, averaging 234 kg (Table 2). Bulls produced the heaviest carcass weight (262 ± 4 kg). These final carcass weights reflect a combination of diet and castration influences through both LWG and dressing-out percentage effects. Steers and castrates on the feedlot had lower dressing-out percentage than similar animals on pasture. On the feedlot, the steers and castrates were similar in dressing-out percentage, but on pasture, the dressing-out percentage of steers was lower than that of the bulls and the castrates.

Carcass physical characteristics

There were significant ($P<0.05$) effects of diet and castration on eye muscle areas, when steers vs castrates, and feedlot vs pasture treatments, were analysed as a factorial. Castrates had larger eye muscle areas than steers, and cattle on pasture had larger eye muscle area than cattle on the feedlot (Table 2). Bulls had significantly ($P<0.001$) thicker neck muscles than steers or castrates, although the latter two groups did not differ (Table 2).

Meat characteristics

Steers on the feedlot had higher fat % in the eye muscle than steers on the pasture, but for castrates diet did not affect fat % (Table 2). On pasture, castrates were intermediate between bulls and steers in fat %. There were no effects of castration or diet on meat colour or ultimate pH.

Fat characteristics

Diet did not significantly affect fat depth, although feedlot steers tended to have more fat than pasture steers (Table 2). Castrates were intermediate between bulls and steers for fat depth.

Fat colour and carotenoid concentration in the fat were lower for feedlot animals than for pasture fed groups (Table 2). There were no effects of castration, although fat colour tended to be lower in bulls than in castrates or steers on pasture.

TABLE 1: Fasted liveweight and liveweight gain (mean ± SEM) of cattle during the finishing period, as influenced by castration and feeding regime.

		Feedlot		Pasture		
		Castrates	Steers	Bulls	Castrates	Steers
Liveweight :	14 Feb	367 ± 3	359 ± 3	383 ± 3	367 ± 3	359 ± 3
(kg)		b	c	a	b	c
	26 May	462 ± 7	458 ± 7	485 ± 7	436 ± 7	447 ± 7
		b	b	a	c	bc
Liveweight gain		0.93 ± 0.04	1.01 ± 0.04	0.99 ± 0.04	0.67 ± 0.04	0.83 ± 0.04
(kg/hd/day)		ab	a	a	c	b

[1] Means within rows with different letters differ significantly

TABLE 2: Carcass characteristics (mean ± SEM) of cattle at trial termination as influenced by castration and feeding regime.

	Feedlot		Pasture			Statistical[1]
	Castrates	Steers	Bulls	Castrates	Steers	significance
Carcass weight (kg)	236 ± 4	230 ± 4	262 ± 4	234 ± 4	235 ± 4	***
	b[2]	b	a	b	b	
Dressing-out percentage[3]	52.8 ± 0.3	52.4 ± 0.3	55.0 ± 0.3	54.8 ± 0.3	53.8 ± 0.3	***
	c	c	a	a	b	
Neck muscle thickness (mm)	42 ± 2	37 ± 2	62± 2	40 ± 2	37 ± 2	***
	b	b	a	b	b	
Eye muscle area (cm^2)	66.4 ± 2.5	62.5 ± 2.5	71.4 ± 2.6	72.4 ± 2.5	67.1 ± 2.5	***
	ab	b	a	a	b	
Ultimate pH	5.69 ± 0.09	5.63 ± 0.09	5.91 ± 0.09	5.89 ± 0.09	5.78 ± 0.09	NS
Fat % in eye muscle	1.86 ± 0.17	2.81 ± 0.17	1.66 ± 0.17	1.80 ± 0.17	2.16 ± 0.17	***
	bc	a	c	bc	b	
Eye muscle a* value[4]	12.2 ± 1.7	14.6 ± 1.7	12.0 ± 1.7	12.8 ± 1.7	16.0 ± 1.7	NS
Fat depth at 12th rib (mm)	1.89 ± 0.35	3.12 ± 0.34	1.40 ± 0.35	1.85 ± 0.34	2.48 ± 0.35	**
	bc	a	c	bc	ab	
Fat b* value[4]	12.5 ± 0.6	12.0 ± 0.6	16.7 ± 0.6	18.7 ± 0.6	17.1 ± 0.6	***
	c	c	b	a	ab	
Fat carotenoid concentration[5]	1.6 ± 0.2	1.9 ± 0.2	3.1 ± 0.2	3.3 ± 0.2	3.6 ± 0.2	***
(μg/g fat fresh weight)	a	a	b	b	b	

1 **, *** indicate significant differences among treatments at P<0.01 and P<0.001, respectively; NS = not significant (P>0.05)
2 Means within rows with different letters differ significantly
3 Based on fasted liveweight recorded at slaughterhouse
4 Chromameter colour values, a = redness, b = yellowness
5 Subcutaneous fat from 12/13th rib

DISCUSSION

Bulls grew faster than steers, with the advantage ranging from 12.3% (10-17 months-of-age) to 19.2% during the finishing period. This superiority of bulls over steers is consistent with previous comparisons (Field, 1971; Arthaud *et al.,* 1977). Castration pre-puberty at approximately 10 months-of-age did not result in any short-term weight loss, nor did it suppress LWG relative to bulls for the following 2 months, although LWG of both groups was low during this late-winter period. Post-pubertal castration, in contrast, resulted in short-term weight stasis and reduced LWG even compared with steers. This low LWG as castrates eroded the LW advantage they had as bulls over steers at post-pubertal castration and at slaughter these animals were no heavier, in LW or carcass weight, than steers.

Carcass evaluation indicated that modification of several characteristics occurred during the finishing period in response to post-pubertal castration, although the change varied with attribute being considered. Post-pubertal castrates lost the large neck muscle characteristic of bulls, but retained the large eye muscle area of bulls, relative to steers. Fat depth at 12th rib and fat % in the eye muscle of post-pubertal castrates were intermediate between those of bulls and steers.

Feedlot cattle, regardless of age of castration, grew faster than equivalent animals fed on brassica crop and pasture. The intention was to manage feed allocation to maintain equivalent LWG's of feedlot and pasture animals to ensure carcass evaluations were made at similar carcass weights. However, while LWG differed between treatments, carcass weights were similar for the two feeding treatments because dressing % was higher for the pasture fed cattle. The feedlot diet reduced fat yellowness, and this was related to the lower fat carotenoid concentration of the feedlot cattle. This effect is consistent with a low carotenoid concentration in the feed on offer (Morgan and Everitt, 1969). However, effects of diet on fat deposition during the feeding period was not consistent between steers and castrates. On the feedlot, steers laid down more subcutaneous and intra-muscular fat than castrates, whereas on pasture steers and castrates were similar in both fat depth over the 12th rib and fat % in the eye muscle. This is probably a reflection of the lower digestible-energy concentration of the pasture diet, particularly the grass component during autumn (Marsh, 1975), and the greater energy expenditure associated with grazing compared with the feedlot environment.

This trial was conducted with a class of cattle available on the research farm that were probably not ideal for this experiment. Friesian-cross cattle do not have a high propensity to fatten at this weight and age. Traditional beef breeds approaching greater carcass weight may have been even more responsive to the treatments compared.

The results indicate that post-pubertal castration can be used to modify carcasses meat and fat characteristics. This, in conjunction with specific diets, represents a strategy to produce carcass in response to market signals. Offsetting these advantages are the lower LWG as a result of post-pubertal castration. Age and LW at which post-pubertal castration is done, and length of the finishing period are factors which could be researched in order to ‘lock-in’ the advantage of greater LWG as bulls, prior to finishing as castrates.

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