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Short-term grain feeding and its effect on carcass and meat quality

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ABSTRACT

Forty-five crossbred steers weighing 540-580 kg were assigned to three treatment groups. Group 1 received pasture only for 58 days; Group 2 grazed at a similar herbage mass to Group 1 and were supplemented with 4 kg/hd/day of a concentrate ration; Group 3 were on a feedlot and fed 8 kg/hd/day of concentrate together with 2.0 kg/hd/day of straw. Groups 2 and 3 each had a 28 day pre-conditioning period followed by a 30 day concentrate feeding period.

Final fasted liveweight, liveweight gains, and carcass weights for concentrate, concentrate plus pasture and pasture alone groups were 546 ± 9, 548 ± 9, 547 ± 8 kg; 0.33 ± 0.09, 0.42 ± 0.09, -0.05 ± 0.09 kg/hd/day and 293 ± 7, 315 ± 4 and 313 ± 4 kg, respec tively.

The concentrate plus pasture and pasture only fed groups had greater fat depths. Ultimate pH was slightly lower in concentrate fed than pasture fed cattle but there were no differences in fat colour or tenderness as measured in the laboratory. Plasma carotene levels were significantly lowered by a factor of 10 in the concentrate fed group compared to the grass fed group, but this did not affect fat colour when measured subjectively at the meat processing plant or objectively in the laboratory. Apparently feeding concentrates for 30 days is insufficient to affect fat colour characteristics.

Keywords: beef cattle; grain feeding; liveweight gain; carcass and meat quality.

INTRODUCTION

New Zealand's ability to capitalise on the new North Asian Beef markets (Japan, South Korea, Taiwan) is limited by its reliance on pasture finishing systems. Grass-fed beef is at a disadvantage in terms of fat colour and economic production strategies to overcome this should be investigated (Forgie, 1993).

Longer-term feedlotting (>60 days) is unlikely to become widespread in New Zealand due to high grain prices, but an improvement in the quality of grass-fed beef, exported to Japan in particular, could be achieved by finishing cattle on a grain feeding regime.

Pastures contain high concentrations of carotenoids and the accumulation of these carotenoids in the fat of cattle is the major cause of the yellow colour of beef fat (Morgan and Everitt, 1969; Yang *et al.,* 1992). The carotenoid concentration and hence yellow colour of beef fat can be reduced by feeding cattle diets low in carotenoids for 28-56 days before slaughter (Craig *et al.,* 1959; Dinus and Cross, 1978; Forest, 1981; Strachan *et al.,* 1993). However, some researchers have found no effect on fat colour when grain was fed for periods of less than 60 days (Bidner *et al.,* 1981; Yang *et al.,* 1993) while Knight *et al.,* (1996) reported no change in beef fat colour after feeding a 70/30 barley/pasture silage mix for 62 or 104 days on a feedlot.

The aim of this experiment was to determine the effects of feeding a high-concentrate ration for 30 days prior to slaughter, either at pasture or in a feedlot, on steer liveweight gain, carcass and meat quality characteristics and plasma carotenoid levels.

MATERIALS AND METHODS

Forty five Angus-cross steers were weighed and randomly allocated to three groups on 4 January (day-28). One group (pasture alone = PAST) grazed pasture (Dry Matter Digestibility (DMD) = 52%) throughout the entire duration of the trial at an allowance such that liveweight gain would be approximately 0.5 kg/day. The second group (concentrate plus pasture = CONC/PAST) grazed at a similar pasture allowance in an adjacent paddock to the pasture alone group and were supplemented with a 4 kg/hd/day of a concentrate ration (DMD=81%). The third group (concentrate = CONC/STR) were penned on a feedlot and fed an allocation of 8 kg of concentrate and 2 kg of barley straw (DMD = 37%) per head per day.

The concentrate ration was barley based and processed into pellet form. It contained 2g/kg of concentrate dry matter of a supplement mix consisting of a mineral and vitamin pre-mix, limestone and sodium bicarbonate (Na_2Co_3) in the ratios of (1:10:15). The proportion of concentrate in the diet in the CONC/PAST and CONC/STR groups was increased gradually from approximately 20% of feed dry matter to the prescribed levels over a 28 day pre experimental period.

Fasted animal liveweights were recorded on days 0 and day 30 and blood samples for plasma carotenoid were collected from each steer on days -21, 14 and 28. Blood samples were collected by tail venipuncture and were analysed for plasma caroteroid levels according to Knight *et al.,* (1994).

The steers were slaughtered on day 30 at a commercial abattoir. Carcasses were weighed, and kidney, intramuscular and subcutaneous fat samples were collected for objective measurement of fat colour (Khadem *et al.,* 1995). The carcasses were stored in a chiller for 24 hours before being quartered between 12th and 13th rib. Fat depths were measured over the *longissimus thoracis* muscle at the point of quartering (Khadem *et al.,* 1995).

A sample of the same muscle was dissected from the right side of each carcass within 90 minutes post-mortem and then processed, frozen, stored and used to determine ultimate pH, meat colour, and Warner Bratzler (WB) shear force values of the cooked meat as described by Khadem *et al.,* (1995).

Data were analysed using GLM procedures of the SAS statistical package (SAS, 1985). Carcass weight was used as a covariate where appropriate.

RESULTS AND DISCUSSIONS

The concentrate fed groups were introduced to their concentrate portion of the ration gradually over a four week period. This was done by increasing the ration by 1 kg each week until 4 kg/hd/day was reached. During this time both of these groups lost liveweight (0.5 and 0.7 kg/day for CONC/PAST and CONC/STR, respectively) relative to the grass fed group as they adjusted to the concentrate ration. However, once adjusted to the ration the fasted liveweight gains of the CONC/STR and CONC/PAST groups were significantly (P<0.001) greater than the PAST group (Table 1). The fasted liveweight gains were considerably less than those of steers of a similar weight and fed on a similar diet reported by Knight *et al.,* (1996). However, the unfasted liveweight gains for the period (day 0 to day 30) were 0.68, 1.08 and 0.01 kg/hd/day for the CONC/STR, CONC/PAST and PAST groups respectively, which are similar to those reported by Knight *et al.,* (1996).

The lower carcass weight of the concentrate fed group (Table 2) was associated with a lower dressing out percentage possibly reflecting a larger gut fill and a lower fatness level at the time of slaughter. Muir *et al.,* (1992) also found that concentrate fed cattle had lower dressing out percentages than pasture-fed cattle when slaughtered 6 weeks after concentrate feeding began, but that this difference was reversed after 10 or 15 weeks of feeding.

The CONC/PAST and PAST fed groups had greater fat depths between the 12th and 13th ribs, but this difference was not significant when adjustments were made for differences in carcass weight. There were no differences in intramuscular fat levels. Ultimate pH was slightly lower for the concentrate fed than pasture fed cattle (P<0.10) which is consistent with the higher cooking loss for that group (Purchas and Aungsupakorn, 1993).

The WB shear force values were higher in the concentrate fed cattle reflecting less tender meat, which was not expected on the basis of the mean ultimate pH values of the groups as shear values have been reported to increase as ultimate pH increases from about 5.5 to 6.1 (Purchas and Aungsupakorn, 1993). For the current set of data the mean of 5.84 for the PAST group resulted mainly from high values above 6.60 and values below 5.70 in parts of the pH/shear force curve where shear force values are relatively low. In addition the small number of samples in the pH range between 5.8 and 6.3 did not have particularly high shear values which reflects the looseness of the pH/shear force relationship (Purchas and Aungsupakorn, 1993).

There were no differences in fat colour measurements taken on any of the fat depots (Table 3). Plasma carotenoid levels were reduced by 93% in CONC/STR cattle and 25% in CONC/PAST fed cattle, but this decrease did not affect fat colour. Yang *et al.,* (1993) also

TABLE 1: The effect of feeding steers concentrate plus straw, concentrate plus pasture and pasture alone for 30 days prior to slaughter on fasted liveweight (kg) and fasted liveweight gain (kg/day) (mean (SEM).

	Treatment Groups		
Parameter	CONC/STR[1]	CONC/PAST	PAST
No. of animals	15	15	15
Initial liveweight (day 1)	537 ± 9	536 ± 9	548 ± 9
Final liveweight (day 30)	546 ± 9	548 ± 9	547 ± 9
Daily liveweight gain	0.33 ± 0.09^{b}	0.42 ± 0.09^{b}	-0.05 ± 0.09^{a}

[ab] Means without common letters in their superscripts are significantly different (P<0.05)

[1] CONC/STR = concentrate plus straw, CONC/PAST = concentrate plus pasture and PAST = pasture alone

TABLE 2: The effect of feeding steers concentrate plus straw, concentrate plus pasture and pasture alone for 30 days prior to slaughter on carcass and meat quality characteristics.

	Treatment Groups			
	CONC/STR	CONC/PAST	PAST	RSD[1]
Number of Animals	15	15	15	
Carcass wt (kg)	292.9^{a}	314.9^{b}	313.1^{b}	19.6
Subjective fat colour	4.9	4.9	4.5	0.70
Marbling score (1 - 12)	1.47	1.20	1.73	0.77
Kidney & pelvic fat (kg)	4.00^{a}	4.86^{b}	4.79^{ab}	1.15
Fat depth (mm)	6.53^{a}	10.23^{b}	9.73^{b}	3.01
Muscle colour[2] L*	31.78	32.03	31.67	1.90
a*	23.53	22.88	21.97	3.77
b*	10.12	9.81	9.18	2.26
Ultimate pH	5.60	5.62	5.84	0.52
Warner-Bratzler (WB) shear force parameters:				
WB Work done (kg)	4.62^{b}	3.89^{ab}	3.32^{a}	1.29
WB Initial yield (kg)	8.28	7.08	7.54	3.91
WB Peak force (kg)	15.74^{b}	13.23^{ab}	10.67^{a}	5.16
Cooking loss(%)	30.4^{b}	29.8^{ab}	27.4^{a}	3.5
Intramuscular fat %	2.43	2.60	2.80	1.03

[a,b,c] means without common letters in their superscripts are significantly different (P<0.05)

[1] RSD = Residual standard deviation

[2] L*, a* and b* = brightness, redness, and yellowness, respectively, of meat or fat colour measured with a Minolta Chroma Meter II.

TABLE 3: Effect of feeding steers concentrate plus straw, concentrate plus pasture and pasture alone for 30 days prior to slaughter on fat colour measured objectively or subjectively, and on carotene concentration in the plasma.

		Treatment Groups			
		CONC/STR[1]	CONC/PAST	PAST	RSD[2]
Number of Animals		15	15	15	
Objective measurements of fat colour[3]:					
Intramuscular fat	b*	15.97[ab]	14.94[a]	16.45[b]	1.99
Kidney fat	b*	17.44	16.99	16.97	2.56
Subcutaneous fat[3]	b*	17.15	16.06	16.34	2.64
Fat colour score (1-8)		2.77	2.83	2.50	0.61
Plasma carotene levels (µg/ml)					
11 Jan		10.3	11.1	11.8	2.8
14 Feb		1.3[a]	8.2[b]	11.3[c]	2.4
28 Feb		0.7[a]	8.3[b]	10.4[c]	2.4

[1,2,a,b,c] See footnotes to Table 2
[3] means of 3 measurements

found no decreases in objectively measured fat colour of steers fed a low carotenoid diet for 56 days, despite the serum carotenoid concentration decreasing to 0.4 µg/ml.

Knight *et al.*, (1996) suggested that there may need to be a minimum threshold of plasma carotenoid concentration which must be reached before fat colour is reduced. They suggested that this is below 1-2 µg/ml and that the initial concentrations of plasma carotenoid for cattle grazing pasture would need to be below 6-7 µg/ml to achieve a change in fat colour. The first requirement was met by cattle in the CONC/STR group, but not the second.

It therefore seems that the initial plasma carotenoid levels were too high prior to the cattle entering the feedlot, and although levels were decreased by feeding concentrates there was no effect on fat colour over the 30 days of this trial.

SUMMARY

Feeding cattle concentrates for 30 days prior to slaughter at pasture or in a feedlot does not alter fat colour. It may be that because cattle take time to adjust from a forage diet to a concentrate diet that periods of concentrate feeding longer than the 30 days used in this experiment are required to change fat colour characteristics.

ACKNOWLEDGEMENTS

We gratefully acknowledge the C.Alma Baker Trust for financial support of the research programme and to AgResearch for performing the carotene assays.

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