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RELATIONSHIP BETWEEN CATTLE FAT COLOUR AT WEANING AND SLAUGHTER

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ABSTRACT

The purpose of this study was to determine the relationship between total carotenoid concentration in adipose tissue of cattle and subjective fat colour scores (FCS) as estimated at weaning and at slaughter. Many positive and highly significant correlations between carotenoid content and fat colour scores were observed when animals were either pasture or grain fed. The study demonstrates that fat colour at slaughter can be predicted based on weaner performance, regardless of the breed or feeding regime.

Keywords: carotenoids, fat colour score, cattle, yellow fat

INTRODUCTION

Many consumers do not like meat with excessively yellow fat as they believe it indicates old animals. This is partially true, however, there are other factors which can cause this effect in young animals. Pastures rich in green grass contain carotenoid pigments which are consumed and deposited in adipose tissue. A subjective assessment, which is highly correlated with the carotenoid content can predict satisfactorily yellowness of fat at slaughter. Such assessments can not be made in the field though as they require specific conditions (e.g. light, temperature, etc.). A high correlation between total carotenoid concentration and a 5-point scale subjective assessment was reported for biopsy samples (Kruk *et al*, 1998). Therefore, the aim of this study was **(i)** to investigate the relationship between carotenoid concentration in adipose tissue and subjective fat colour scores (FCS) as assessed at weaning and slaughter, and **(ii)** to investigate the prediction of fat colour score at slaughter based on weaner performance.

MATERIAL AND METHODS

Animals and management. The animals used in this study were part of the Davies Cattle Gene Mapping Herd maintained at Martindale in South Australia (Kruk *et al* 1997). They were born between April/May in 1995 and 1996, and represented 5 breed combinations: pure Jersey (J), pure Limousin (L), F1 (LJ) and reciprocal crosses between the Jersey (¾ J ¼ L) and the Limousin (¼ J ¾ L). The group born in 1995 consisted of 2 cohorts: females, which were finished in the feedlot for 70 days and slaughtered at 16 months of age, and males, which were finished in the feedlot for 170 days and slaughtered at 25 months of age. The 1995 animals comprised of pure Jersey and Limousin cattle. The animals born in 1996 (males and females) were divided into 2 cohorts. Cohort one, consisting of pure Jersey, ¾ Jersey and ¾ Limousin cattle, were slaughtered after pasture feeding at the age of 20 months and the second cohort, consisting of ¾ Jersey and ¾ Limousin cattle, were slaughtered after 240 days on a high grain diet (33 months of age).

Sample collection preparation and analyses. Adipose tissue biopsy samples from 300 days old weaners (341 animals) were collected in 1996 and 1997 from the base of the tail and processed as described by Malau-Aduli *et al* (1995) except that tissue was removed with use of a scalpel. Fat from slaughtered animals 500-600 days was collected from the 12^{th}–13^{th} rib area on the day of slaughter from the chiller (179 animals). Animals were fed to the same fat depth regardless of sex. Total carotenoid content in the fat samples was analysed as described by Kruk *et al* (1997). Fat colour score of adipose biopsy samples was assessed immediately after removing the fat from the biopsy site and rinsing with water. Fat colour score from carcasses was assessed according to AUS-MEAT® specifications on a 10-point scale. All biopsy and carcass fat samples were placed in the plastic vials, and stored in -20°C under N_2 gas until analysed.

Statistical analyses. Least squares analysis of variance was carried out separately for classes of fat colour score at weaning, fat colour score at slaughter and days on feedlot, using Proc GLM (SAS 1989). Least squares means and differences between means were computed. Correlations between total carotenoids at weaning and at slaughter as well as fat colour scores were calculated using Proc CORR (SAS 1989). Simple linear regression was used to test for the difference between FCS and carotenoid concentrations at weaning and slaughter. The hypothesis that the equation slopes were not different from each other was tested using a t-test.

RESULTS

Correlation between carotenoid concentration and fat colour scores. The increased concentration of total carotenoids in biopsy and carcass adipose tissue was accompanied by higher subjective fat colour scores (Table 1). The correlation were high (Figure 1A) and there was no significant difference between the equation slopes describing these correlations. There was also a significant difference between the range of carotenoid concentration in biopsy fat as assigned to different subjective fat colour score classes (Table 1). A similar trend to biopsy samples was observed at slaughter where the range of carotenoid concentration within the various subjective fat colour scores differed significantly with the exception of a few adjacent scores. There were also positive correlations between carotenoid content in biopsy fat and in carcass fat as well as between FCS at weaning and at slaughter (r=0.58, and r=0.70 respectively, P<0.001). The data set used to estimate the AUS-MEAT® 10-point scale fat colour score comprised the whole range of scores except the score of 6 and the highest score of 9.

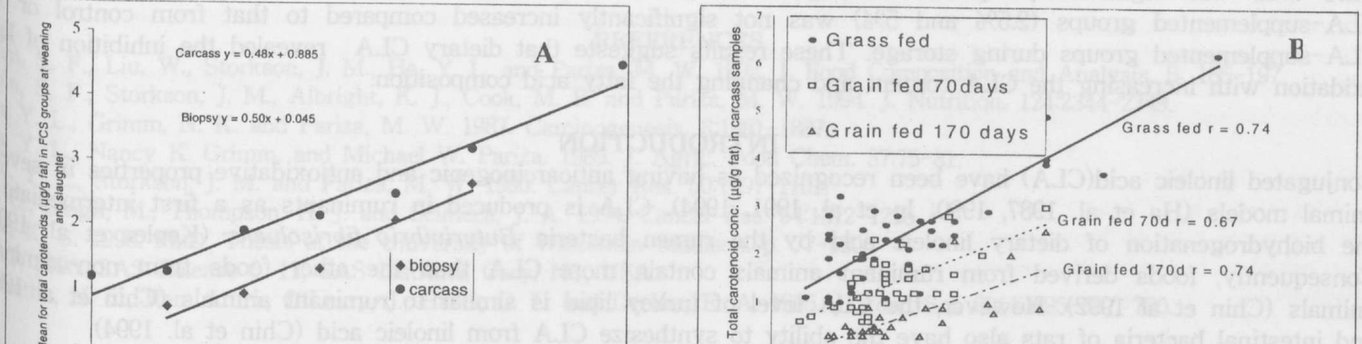
Effect of breed and feeding regime on subjective fat colour score. A significant difference was observed when comparing FCS in carcasses of grass fed and grain fed cattle. The grass fed animals had higher FCS than animals fed for 70 and 170 days with grain (data not presented). The trend for FCS observed in different feeding groups was similar for total carotenoid content (Figure 1B), where more carotenes were present in the fat of grass fed animals but time of feed was confounded with age, year and sex. Correlations between concentration of carotenoids in biopsy and carcass fat were high and similar in different feeding groups. Higher FCS were found in Jersey and Jersey crosses, whereas pure Limousin and ¾ L had FCS of 0 and 0-2, respectively.

Table 1. Means for total carotenoid content (μg/g) in subcutaneous fat as assigned to different subjective FCS at weaning (bio) and at slaughter (car).

		FCS	0	1	2	3	4	5	7	8	Σ
Carotens μg/g fat	bio	μ	-	0.73 ±0.04^a	0.93±0.02^b	1.32±0.05^c	2.08±0.14^d	2.65±0.10^e	-		
		n	-	63	229	34	5	10	-		341
	car	μ	1.18±0.09^a	1.26±0.18^a	1.90±0.18^{bc}	2.14±0.19^{cd}	2.49±0.22^d	3.20±0.28^e	4.62±0.28^f	6.20±0.63^g	-
		n	76	52	20	11	8	6	5		179

Note: FCS = fat colour score, $^{a-g}$ within row means followed by the same letter are not significantly different (P>0.05), n = number of animals, μ = mean.

Figure 1. Correlation between (A) FCS and carotenoids, and (B) total carotenoids at weaning and slaughter.



DISCUSSION

A high correlation between total carotenoids and FCS at weaning with total carotenoids and FCS at slaughter have been reported for the first time herein. This may provide a means of predicting carcass fat colour based on weaner performance. Subjective FCS of weaner biopsy and slaughter samples can be expressed by a range of carotenoid concentrations which differ significantly for each score. As reported by Walker *et al* (1990), high value meat markets accept AUS-MEAT® fat colour scores of 1 and 2 without penalizing carcasses for excessively yellow fat. The concentration of carotenoids in our study indicates that about 2 μg of carotenoids in 1g of carcass fat is associated with FCS of 2 and higher, and this level would be the disqualification factor from the profitable Japanese market. The 2 μg of carotenoids in 1g of fat in grain fed animals relates to a fat colour score of 4 and higher in weaners. This clearly demonstrates that the animals with a fat colour score of 4 and higher at biopsy also have scores 2 and higher in AUS-MEAT scoring system, despite of the number of days on feedlot. This was demonstrated by similar and high correlations between the equations representing carotenoid concentrations and FCS at weaning and slaughter after different feeding management.

Pasture fed animals which consume diets abundant in carotenoids constantly increase the concentration in the adipose tissue. The results demonstrate that grass fed animals which had FCS of 1 at weaning, have scores of 2 and higher at slaughter. Two diverse breeds used in our study show that the Limousin cattle always have low content of carotenoids in their fat and can reduce fat colour if fed for a short period of time on grain. The ¾ L ¼ J crosses had FCS from 0-2, but were able to reduce yellow fat colour similar to pure Limousin. Different breeds present in various cohorts could be confounded with feeding regime, sex or age. However, no significant breed by cohort interactions and no sex differences have been found previously (Kruk *et al*, 1998). Some Jersey and ¾ J ¼ J cattle even after 240 days of grain feeding still had high FCS. This had been reported by other authors (Strachan *et al*, 1993) and is presumably due to a major gene(s) in these breeds (Kruk *et al*, 1998). The higher FCS in ¾ Limousin cattle compared with pure Limousin cattle could be the result of crossbreeding with Jersey cattle which introduced the yellow fat gene to the backcross animals. Irrespective of breed variation and feeding systems, FCS at slaughter can be predicted based on the animal performance at weaning.

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