The Relationship Between Fat Colour and Fatty Acid Composition in New Zealand Grass Fed Beef

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ABSTRACT

Fat samples were collected from 20 Angus grass-fed steers 24 hours after slaughter. Fat colour was measured with a Chromameter (b* values) and the carotenoid concentration and fatty acid (FA) composition of the fat were analysed. As b* values, and therefore the yellowness of the fat, increased the proportion of *cis* monounsaturated FA increased ($r = 0.72$; $P<0.0001$). The relationship was not as strong for carotenoid concentration even though the correlation between carotenoid concentration and b* values was high ($r = 0.86$; $P<0.001$). The conclusions were that the potential health advantages of beef with yellow fat compared to beef with white fat were small, and the relationships appeared to mainly apply within a herd.

INTRODUCTION

There is a preference for beef without yellow fat in some Asian markets, and this can reduce the acceptability of grass-fed beef from N.Z. The yellow colour is due to accumulation of carotenoids (ß-carotene and lutein) in the fat (Yang et al. 1992). There is no odour or taste associated with these carotenoids. Thus it may be cheaper to persuade consumers to accept beef with yellow fat than to change the fat colour of N.Z. grass-fed beef. This would be easier if it could be shown that beef with yellow fat had health advantages over beef with white fat.

Australian work (Zhou et al. 1993) has indicated that as fat became yellower the proportion of *cis* monounsaturated fatty acids (FA) increased, and saturated and *trans* monounsaturated FA decreased. There are health advantages in increasing the proportion of unsaturated FA in human diets (Jonnalagadda et al. 1996).

The aim of the trial presented in this paper was to determined the FA composition in fat from grass-fed N.Z. steers and compare it with the fat colour and fat carotenoid concentration.

MATERIALS AND METHODS

Subcutaneous fat samples were collected from 20 randomly selected carcasses from grass-fed Angus steers. They had been in the chillers at Manawatu Beef Packers Ltd for 24 hours after slaughter. The yellowness of the fat (b* values) was measured with a Minolta Chromameter.

The carotenoid concentration in fat samples was analysed by the method of Kirton et al. (1975). About 0.3-0.4 g of fat was saponified with 3 ml of 20% KOH in ethanol at 60°C for 45 minutes then cooled to room temperature. Two ml of water were added before extracting the sample with 2 ml of petroleum ether. The petroleum ether extract was removed and dried with anhydrous sodium sulphate. The absorbency of the extract at 450 nm was measured on a spectrophotometer. This extraction includes lutein, and because 450 nm is near the optimum absorbency for lutein, the assay gives the combined concentration of both carotenoids. However, β-carotene was used to prepare the standards and carotenoid concentration was presented as µg carotene/g fat.

Adipose tissue samples were directly trans-esterified (Lepage and Roy 1984) using an adaptation of van Wijngaarden's method (1967). Approximately. 20 mg of tissue was heated, with vigorous stirring, at 80°C for 10 min with 1 ml 6% (w/v) KOH in methanol in a screw-capped test-tube. On cooling, 2 ml BF_3-methanol (14% w/v) was added and the contents of the tube were heated for a further 5 min. About 2 ml pentane and 4 ml distilled water were added to the cooled tube and the contents vigorously shaken. A portion of the upper layer that formed on standing was transferred to a sample vial, which was then crimp-capped.

Gas chromatographic separations of fatty acid methyl-esters were carried out with a Hewlett-Packard Model 5980A instrument equipped with a 7673A autoinjector. The column used was an ECONO-CAP Carbowax 30 mX0.25 mmX0.25µm from Alltech Assoc., Inc. (Deerfield, IL, USA). Hydrogen was used as the carrier gas, with the column head pressure set at 75 kPa. The injection port and detector (flame ionization) were maintained at 240°C and 250°C, respectively. The column oven was held at 100°C for 2 min and then programmed to 160°C at 10°C/min, then to 240°C at 2°C/min and held at the maximum temperature for 5 min.

Statistical analysis

The correlation between fatty acid composition and b* values and carotenoid concentrations in the fat were analysed used the proc corr procedure in SAS (SAS Institute Inc. 1987). As in the work of Zhou et al. (1993), the *trans* monounsaturated FA were included with the saturated FA when calculating total saturated and unsaturated FA, and the ratio between these two traits.

RESULTS AND DISCUSSION

The mean carotenoid concentration (1.54 ± 0.11 µg/g fat) and b* value (16.7 ± 3.8) were both higher in these fat samples than in the Australian work (0.70 ± 0.05 µg/g fat and 11.4 ± 0.7 respectively). The correlations in Table 1 indicate that as the fat became yellower and b* values increased, the proportions of the various saturated FA decreased and *cis* monounsaturated FA increased. The strongest relationship was between the ratio of *cis* monounsaturated : saturated FA and the b* values (Fig 1). The relationship was not as strong for fat carotenoid concentration, even though the correlation between carotenoid concentration and b* values was high ($r = 0.86$; $P<0.001$).

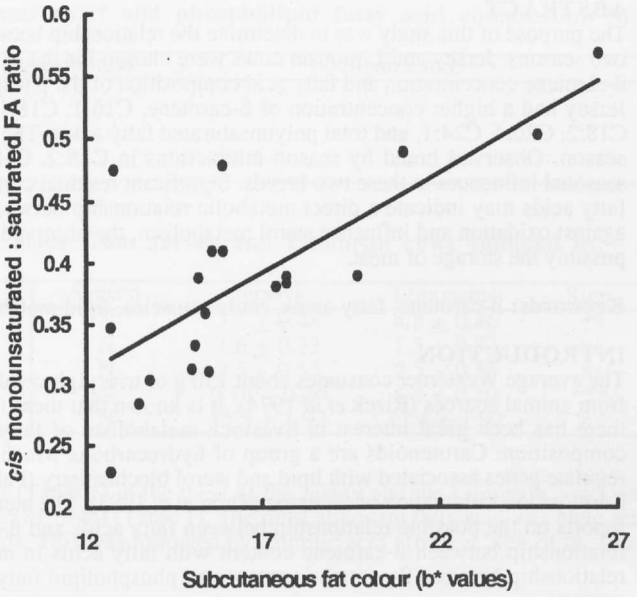
Despite the fat samples in the Australian work having lower b* values, the proportion of *cis* monounsaturated FA (46.6%) was higher and saturated FA (48.2%) lower than in this trial. This was mainly because of the much higher levels of C18:1 *cis* (40.9 ± 1.03 g/100 g) in the subcutaneous fat of the steers used in the Australian trial. Whereas the Australians found a negative correlation between b* values and C 18:1 *trans* ($r = -0.61$ $P < 0.001$), there was no correlation in this trial. Recent studies in humans indicate that *trans* monounsaturated FA behaves like saturated FA and increases low-density lipoprotein cholesterol levels in the blood (Katan and Zock 1995). Therefore diets aimed at reducing the risk of coronary heart disease should be low in both *trans* monounsaturated and saturated fatty acids. This was achieved with increasing yellowness of the beef fat in the Australian work but only for the saturated FA in this trial. These differences possibly reflect differences in the nutrition and breed of steers used in the two trials. Half the steers used in the Australian trial were Brahman which grazed buffel grass, and the rest were Hereford cross steers that were grain-fed for 70 days before slaughter. While there is no data on the pasture grazed by the Angus steers in this trial, it is likely to have been mainly rye grass and white clover

TABLE 1: Fatty acid composition and the correlations with b* values and carotenoid concentration in fat samples from steers (Mean ± SE; n = 20).

Fatty acids	Composition (g/100g FA)	Correlation coefficients	
		b* value	Carotenoid
C14:0	4.28 ± 0.13	-0.59**	-0.47*
C14:1*cis*	0.71 ± 0.06	0.51*	0.23
C16:0	29.00 ± 0.39	-0.38	-0.40
C16:1 *trans*	1.26 ± 0.07	0.54*	0.39
C16:1 *cis*	2.40 ± 0.19	0.59**	0.41
C17:0	1.26 ± 0.03	-0.64**	-0.49*
C17:1 *cis*	0.62 ± 0.04	0.62**	0.32
C18:0	21.4 ± 0.92	-0.57**	-0.32
C18:1 *trans*	10.85 ± 0.20	0.25	0.18
C18:1 *cis*	23.78 ± 0.73	0.72***	0.51*
C18:2 *cis*	0.27 ± 0.01	-0.40	-0.36
C18:3 *cis*	0.28 ± 0.01	-0.21	-0.07
Others[a]	3.88 ± 0.04		
Saturated[b]	71.93 ± 0.96	-0.72***	-0.49*
cis monounsat	27.52 ± 0.97	0.72***	0.49*
cis mono/sat[c]	0.39 ± 0.02	0.73***	0.51*

[a] mainly branched saturated FA;
[b] straight + branched chain FA + *trans* monounsaturated FA
[c] *cis* monounsaturated FA : saturated FA ratio
* = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$.

Figure 1: The relationship between the ratio of *cis* monounsaturated to saturated fatty acids and subcutaneous fat colour (b* values). The equation for the regression line is ratio = 0.114 + 0.016* (fat colour); r = 0.73; $P<0.001$.



CONCLUSIONS

There are potential health advantages of beef with yellow compared to white fat but the they are small. For cattle of similar breeds and nutrition the beef with yellower fat will have a higher proportion of unsaturated FA. However this relationship may not occur when comparing cattle of different breeds or cattle on different nutrition (ie grain vs grass-fed).

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