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CAROTENOID CONCENTRATION IN DIFFERENT ANTOMICAL LOCATIONS OF SUBCUTANEOUS FAT IN CATTLE

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ABSTRACT

The concentration of total carotenoids in various anatomical locations of cattle adipose tissue was studied. Results demonstrate that there were no significant differences between the left and right sides of carcasses, regardless whether the samples were fresh or chilled. There were also no significant differences between sites as expressed per gram of wet fat or dry fat, despite the fact that the water content varied between the sites. The study demonstrates that the total carotenoid concentration does not differ between anatomical locations of subcutaneous fat in cattle even when the concentration is high. Since there are no differences, comparisons between various studies can be made, provided the results are expressed as total carotenoid per gram of subcutaneous fat.

Keywords: carotenoids, anatomical location, subcutaneous fat, cattle

INTRODUCTION

Fat colour is one of the major criteria that determines the acceptability of meat by the consumers. Carcasses with excessively yellow fat are not desirable, and consequently, are eliminated from the market or significantly downgraded in price. Fat colour can be estimated by subjective assessment, chromameter readings, or measurement of β-carotene or total carotenoid content in the fat (Gaunt *et al*, 1994). The subjective assessment depends on assessor skills, and the chromameter readings can be influenced by the chilling and storage conditions (Seirer *et al*, 1992). Only laboratory evaluation, although laborious and time consuming, can provide a precise measurement. Since the techniques vary between studies, the results are difficult to compare.

The site of fat sampling is also important. Some anatomical sites are more accessible than the others, especially for biopsy sampling. There have been few studies which compare fat colour in different anatomical locations of subcutaneous fat. Based on chromameter values, some authors have reported that there are no differences between sites (Seirer *et al*, 1992). However, they only investigated a narrow range of yellow coloured fat samples. Moreover, while they reported no site differences, significant differences were observed between fresh and chilled fat samples. It was essential in our work on the metabolism of carotenoids in cattle to resolve this issue and develop appropriate sampling protocols which allow comparisons of our findings with other studies.

MATERIAL AND METHODS

Animals and sampling. The animals used in this study were derived from 2 separate groups. Group one, comprised of unknown animals, provided fat samples for the analysis of carotenoid concentrations in the left and right side of carcasses. Samples from the first group were collected from the slaughter line (10-15 min. after kill) or from the chiller (4-5 hours after slaughter). Fat from randomly selected fresh and chilled cattle carcasses (5 each) was taken from symmetrically adjacent sites (12^{th}-13^{th} rib, shoulder, rump). Group 2 comprised 13 Jersey and 13 Limousin steers (Kruk *et al*, 1997), which had been in a feedlot for 170 days. For the analysis of carotenoid content in various anatomical sites of the same animal, fat samples from the shoulder, ribs, and rump of group 2 animals were obtained in the chiller. The samples were frozen at -20^0C and stored in a N_2 atmosphere until required for analysis.

Sample preparation and analysis. For carotenoid concentration measurements in dry fat, the fat samples were freeze-dried prior to analysis and stored at -20^0C. Total carotenoid concentration was estimated spectrophotometrically as described by Kruk *et al*, 1997. Water content of the fat was calculated as the difference between fresh fat weight and the weight of the same samples after freeze drying.

Statistical analyses. Analysis of variance was carried out to estimate the difference between breeds, anatomical locations, and the interaction between breed and anatomical location, using Proc GLM (SAS 1989). Least squares means and differences between means were computed. Correlations between total carotenoid concentration in different body sites were calculated using Proc CORR (SAS 1989). Test of significance (difference from 0) at $P<0.05$ was determined by BONFERRONI probabilities. As the variation in carotenoid content in left and right half carcasses was very large (by design), simple linear regression was used to test for the differences between the various sites. The hypothesis that equation slopes were not different than 1 and that the intercepts were not different than 0 was tested using a t-test.

RESULTS

Carotenoids in left and right half-carcasses. The difference in fat colour between the left and right sides of the carcasses was determined for range of carotenoid concentrations from 0.9-4.5 μg/g in fresh fat and 0.8-3.0 μg/g in chilled fat (Figure 1). The test for differences between the equations showed that the slopes were not different from 1 and intercepts were not different from 0. The correlations between the left and right sides of the carcasses were high and significant in both fresh and chilled fat (R^2=0.99 and R^2=0.94, respectively).

Carotenoids in commonly sampled sites. The concentration of total carotenoids in rib, rump and shoulder wet fat did not differ significantly between the sites (Figure 2). No difference in these sites was also observed when the carotenoid content was expressed

per gram of dry fat (data not presented). The concentration of total carotenoids in dry fat samples was higher. Breed had an effect on carotenoid concentration in fat. Jersey steers were higher in concentration compared to Limousin steers in both wet and dry fat (0.96 ± 0.03 µg/g vs 0.33 ± 0.03 µg/g and 1.62 ± 0.06 µg/g vs 0.68 ± 0.06 µg/g, respectively). Breed by site interaction was not significant for wet and dry fat samples.

Anatomical location and water content. Water content did vary between the 3 sites tested with the lowest values for rump samples (8.9% ± 0.72). The difference was significant ($P<0.01$) when water content was compared between the rump and ribs and shoulder (11.8% and 12.1% ± 0.72, respectively). Breed also had an effect on water content in fat with Jersey having significantly higher percentage of water than Limousin steers (12.3% and 9.5% ± 0.59, respectively). Breed by site interaction was not significant.

Figure 1. Interrelationship of total carotenoid conc. between left and right half-carcasses in fresh and chilled adipose tissue of cattle.

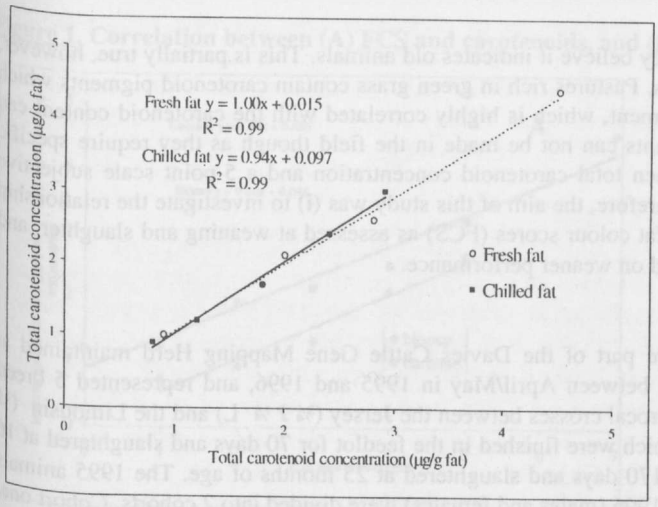
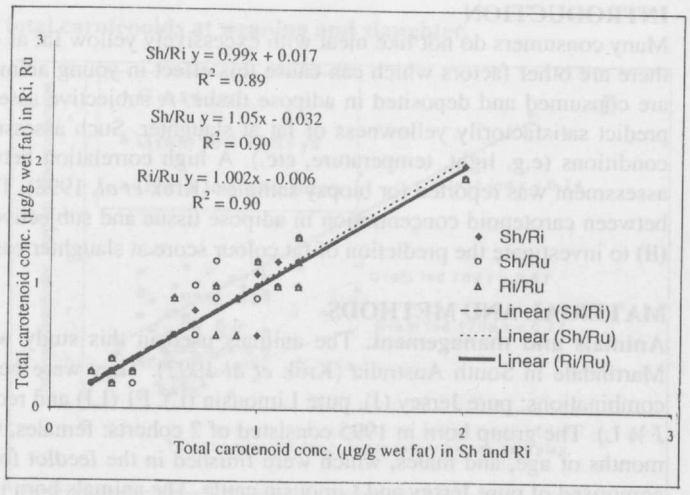


Figure 2. Relationship of total carotenoid conc. between shoulder (Sh), ribs (Ri) and rump (Ru) in wet cattle fat.



DISCUSSION

Carotenoid content in fat is highly correlated with fat colour (Zhou *et al*, 1993). Total carotenoid concentration measured in left and right half-carcasses showed no difference in both fresh and chilled fat, as described by the equations. These findings agree with the other authors (Seirer *et al*, 1992) who did not find differences when measuring fat colour using a chromameter. However, they reported a significant difference between fresh and chilled carcasses. Such differences in carcass fat colour is probably due to the changes in the chiller (eg. fat drying and solidification) which lower the chromameter readings. Measurement of total carotenoids does not have these limitations.

The shoulder, 10^{th}-13^{th} ribs, and the base of the tail are commonly sampled sites for fat in cattle. Total carotenoid concentration measured in these sites did not vary between the sites when the results were expressed per dry or wet fat. Even the difference in water content between rump and the other sites observed in our study did not influence carotenoid measurement. The difference in water content was presumably caused by the conditions in the chiller. The rump area was closely situated to the air inlet and the direct flow of a cold air dried the fat faster than in other locations.

The lack of difference in carotenoid concentration between sites was observed regardless of the breed and range of carotenoid concentrations. Even such diverse breeds as Jersey and Limousin showed no difference in carotenoid concentration between the various anatomical locations. Thus, carotenoid concentration does not differ between various anatomical locations of subcutaneous fat in cattle and results can be compared even when the samples derive from different sites and from different breeds.

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