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BRIEF COMMUNICATION

Effects of stress and nutritional changes on the ranking of cattle on plasma carotene concentrations

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ABSTRACT

Three experiments were carried out to determine the effects of short term nutritional changes, stress and changes in carotene content of the diet on plasma carotene concentrations (PCC) and the relative ranking of the cattle for PCC. None of the treatments affected the ranking of the cattle for PCC even though the changes in dietary carotene intake caused large changes in mean PCC.

Keywords: carotene, fat colour, cattle.

INTRODUCTION

The yellow colour of fat in meat and dairy products from New Zealand pasture fed cattle reduces the acceptability of these products in some markets, especially the high priced Japanese market. β carotene deposition in adipose tissue accounts for 85-90% of the colour in beef fat and colour intensity of fat is correlated ($r = 0.92$) with its carotenoid content. Plasma carotene concentrations (PCC) are correlated to carotenoid content of beef fat ($r = 0.58$) and fat colour ($r = 0.67$) (Morgan and Everitt 1968, 1969). As a selection trait, PCC has advantages over biopsy sampling in that it is not as invasive, repeated samples can readily be taken and it can be used on young animals before substantial subcutaneous fat has been deposited.

The results presented in this paper show the effects of short term nutritional change (Expt 1), stress (Expt 2) and changes in carotene content of the diet (Expt 3) on PCC and consistency of the ranking of cattle on PCC.

Blood samples were taken from the neck in Expt 1 and from the tail in Expts 2 and 3. Blood plasmas were analysed for carotene (C) using a spectrophotometric method (Nino and Shaw 1976) which measures total carotene.

Experiment 1: Starting on 25 November 1991, 10 2 year-old Angus steers were bled at 0900h daily from Monday to Friday for 3 weeks. Over week 1 the steers grazed abundant green pasture (5ha at 3600 kgDM/ha). Green pasture allowance was restricted (2ha at 1450 kgDM/ha) in week 2 but the steers received 4 bales of hay/day. In week 3 the steers were returned to abundant pasture for 2 days and then they were held for 48 hours with access to water but no feed.

There were no short term effects of the 48 hour starvation or the restricted green feed plus hay diet on PCC. Over week 1 there were significant ($P < 0.001$) variations in PCC between days and mean PCC were lower ($P < 0.001$) in week 1 ($10.44 \pm 0.12 \mu\text{g C/ml}$) than weeks 2 ($11.64 \pm 0.12 \mu\text{g C/ml}$) and 3 ($11.24 \pm 0.12 \mu\text{g C/ml}$). There were significant ($P < 0.001$)

differences between the steers in PCC. Mean PCC for each steer over the 3 weeks ranged from $8.48 \pm 0.22 \mu\text{g C/ml}$ to $13.03 \pm 0.22 \mu\text{g C/ml}$.

Rankings of steers for PCC remained relatively constant with average (\pm SD) correlation coefficients for weeks 1, 2, 3 and over the 3 weeks being $r = 0.92 \pm 0.04$, $r = 0.88 \pm 0.07$, $r = 0.84 \pm 0.06$ and $r = 0.78 \pm 0.14$ respectively.

Experiment 2: Fifteen 2-year-old Angus steers were bled at 0900h on 6 days (12, 17, 23 and 25 June and 16 and 17 July) with 3 additional bleeds at 2 hour intervals on 16 July. The steers were randomly allocated on 16 July after stratification on previous PCC, to three treatment groups. The low stress group remained quietly in the yards between bleeds on 16 July while the moderately stressed group was returned to their paddock between bleeds. The high stress group was treated similarly to the moderately stressed group but between the first bleed at 0900h on 16 July and the second bleed the steers were loaded onto a truck and driven 170km over 2 hours.

The stress imposed on the steers had no effect on PCC. There were significant ($P < 0.001$) differences in PCC between steers, with mean PCC ranging from $5.38 \pm 0.334 \mu\text{g C/ml}$ to $15.22 \pm 0.34 \mu\text{g C/ml}$.

Ranking of steers for PCC remained relatively constant over the 9 bleeds with all possible between day correlations for PCC being significant ($P < 0.001$). The average correlation coefficient over the 36 correlations was $r = 0.88 \pm 0.04$ (SD).

Experiment 3: Six Jersey ($281 \pm 6.1\text{kg}$) and 6 Angus ($365 \pm 6.1\text{kg}$) heifers which were grazing green pasture, were bled on 3 February. The heifers were divided into three liveweight groups of 4 heifers each and introduced to a feedlot. On 16 March the heifers received a diet of pellets (75% barley and 25% lupin grain) fed to each liveweight group at 1.1% of the mean liveweight of the group. Barley straw was available *ad lib*. The pellets contained 250 mg C (Rovimix @ A-500 Type P. Roche Products NZ Ltd)/kg DM. On 6 April the diet was changed to pellets containing 0 mg

C/kg DM and feeding continued until 15 June when the heifers were returned to pasture. The heifers were bled every 2-4 days from 16 March to the end of the experiment on 30 June.

The levels of PCC were $14.2 \pm 1.2 \mu\text{g C/ml}$ for Jersey and $11.0 \pm 1.2 \mu\text{g C/ml}$ for Angus. The differences were not significant and breeds were pooled for the rest of the analysis. There were significant ($P < 0.001$) differences between heifers in PCC and the mean concentrations for grass fed heifers ranged from 9.30 ± 1.11 to $16.39 \pm 1.56 \mu\text{g C/ml}$ for Jersey and $6.19 \pm 0.79 \mu\text{g C/ml}$ to $14.33 \pm 1.78 \mu\text{g C/ml}$ for Angus heifers.

Over the period from 16 March to 6 April when heifers were being fed pellets containing 250 mg C/kg DM the mean daily PCC only fluctuated between $6.96 \pm 0.58 \mu\text{g C/ml}$ and $8.20 \pm 0.53 \mu\text{g C/ml}$. On changing the diet to pellets containing 0 mg C/kg DM, the mean PCC decreased rapidly over 27 days from $8.20 \pm 0.53 \mu\text{g C/ml}$ to $2.28 \pm 0.23 \mu\text{g C/ml}$. This was followed by a slow decrease in mean PCC over the next 45 days to a low of $0.61 \pm 0.13 \mu\text{g C/ml}$ on 15 June after which the heifers were returned to pasture. Over the subsequent 15 days to the end of the experiment PCC increased rapidly to $12.58 \pm 0.95 \mu\text{g C/ml}$.

The rankings of the heifers on PCC remained relatively constant over the period they were on the feedlot. The correlation coefficients between PCC on 16 March, and 6 April when the diets were changed, at the end of the rapid decrease in PCC on 1 May, and at the end of feeding of pellets containing 0 mg C/kg DM on 15 June were respectively $r = 0.84$ ($P < 0.001$), $r = 0.76$ ($P < 0.01$) and $r = 0.84$ ($P < 0.001$). In addition the correlation coefficients for the correlation between the PCC of grass fed heifers at the beginning (3 February) and end (30 June) of the experiment was $r = 0.94$ ($P < 0.001$).

DISCUSSION

There was a 2 to 3 fold range between individual cattle in PCC and the short to medium term ranking of cattle on PCC was consistent. The rankings were not influenced by short term nutritional changes, stress or major changes in dietary C intake. This supports earlier research which suggests there are genetic differences in PCC between individual cattle and these could reflect genetic difference in fat colour (Morgan and Everitt 1969).

Short term changes in nutrition and stress had no effect on PCC indicating that there can be some flexibility in the treatment of groups of cattle before blood sampling without compromising the PCC comparisons between cattle. However large changes in dietary C intake caused rapid changes in PCC and suggest PCC closely reflects C absorption by the cattle. This indicates that selection for cattle for high or low PCC can only be made when cattle graze similar pasture at sampling time. Since fat colour represents the long term accumulation of C (Morgan and Everitt, 1969), PCC can only indicate differences in fat colour or C concentrations in the fat if the cattle have been grazed together for most of their life.

In conclusion these results together with those of Morgan and Everitt (1969) suggest that PCC could provide a good indirect selection trait for fat colour and C content of the fat in cattle grazed together throughout most of their life.

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