GROWTH AND CELLULARITY OF FAT DEPOTS IN BRITISH FRIESIAN AND HEREFORD CATTLE

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INTRODUCTION

FRIESIAN and Hereford cattle are known to differ markedly in their partition of adipose tissue between perirenal and subcutaneous depots (Williams, 1978). This could be due to differences in the number and/or size of fat cells. Changes in cellularity of adipose tissue with growth have not been studied extensively in cattle. Cells in the perirenal depot are thought to be larger than those in the subcutaneous depot and it has been suggested that cell recruitment into both depots is completed by 14 months of age (Hood and Allen, 1973), however data are equivocal. In order to study adipose tissue depot growth and its associated changes in cellularity, the perirenal and subcutaneous depots of British Friesian and Hereford steers were examined during growth from 6 to 20 months of age.

MATERIALS AND METHODS

FOLLOWING ad libitum feeding of a complete pelleted diet (11.3 MJME/ kg DM), 4 animals from each breed were slaughtered at 6 months of age, 2 at 13 months and 15 at 20 months. Body depot fats were dissected and samples were taken from the perirenal(P) and subcutaneous (SC - midloin) for determination of lipid content and cell size. In addition, all animals slaughtered at 20 months had adipose tissue samples surgically removed from the same locations at 10, 13 and 17 months of age. Prior to each sampling occasion, the midloin site area (defined by 4 brand marks on the hide) and adipose tissue depth (ultrasonics) were measured in order to calculate relative midloin fat volume (depth x area/area at 6 months).

Adipocyte diameters (>5 μm) were measured in slices of adipose tissue >250 μm using a light microscopic method. Two perpendicular readings were made on each of 50 cells.

RESULTS

THE FRIESIANS were heavier at 6 months (174 ± 6 vs 144 ± 6, kg), grew faster (0.89 ± 0.02 vs 0.75 ± 0.02, kg/day) and were leaner (7.3 ± 1.1 vs 11.6 ± 0.3, 21.1 ± 0.6 vs 23.4 ± 0.1, 28.5 ± 1.0 vs 30.9 ± 0.6, % fat in the empty body at 6, 13 and 20 months, respectively) than the Herefords. The total subcutaneous depot made up a much smaller proportion of total fat in the Friesians (17.6 ± 0.9 vs 24.8 ± 0.6, 27.5 ± 0.2 vs 34.0 ± 0.8, 24.4 ± 0.5 vs 37.9 ± 1.0, % at 6, 13 and 20 months, respectively) and P made up a much greater proportion (10.8 ± 1.1 vs 7.6 ± 0.6, 13.1 ± 0.1 vs 10.5 ± 0.8, 15.3 ± 0.6 vs 10.2 ± 0.4, % at 6, 13 and 20 months, respectively).

The weights of P and SC (adipose tissue overlying l. dorsi between the last rib and the tuber coxa) depots were regressed (using the linear transformation of the allometric relationship) on the live weight, and from these relationships depot weights were predicted (Figure 1). The relative growth coefficients (on live weight) were not different between breeds and were 2.4 ± 0.1 and 2.9 ± 0.1 for P and SC, respectively.

Relative SC adipose tissue volume was greater in the Herefords and the difference increased with age (Figure 2).

P adipocyte volume (Figure 3) increased almost linearly with age and tended to be greater in the Friesians at 17 and 20 months of age. SC adipocyte volume also increased linearly with age until 17 months of age but plateaued thereafter. There was no difference between breeds.

Percentage dry matter (DM%) in the adipose tissue samples increased markedly with age in SC but only slightly in P (Figure 4). DM% was greater in P than SC. Percentage lipid (L%) in the adipose tissue was calculated from the relationship

$$L\% = 1.2442\ DM\% - 30.87 \quad (r = 0.935;\ RSD = 5.6\%)$$

From these parameters, adipocyte number in each of the depots was calculated (Figure 5). Estimated number in P tended to decrease with age, however, this is probably best interpreted as no change. There was a greater number of adipocytes in P of the Friesians than the Herefords. In contrast, estimated actual (from SC weight) and relative (from relative SC volume) adipocyte number in SC tended to increase with age, especially after 17 months of age. Numbers in SC were greater in the Herefords than the Friesians.

DISCUSSION

In this study there was a greater difference in cellularity characteristics between depots than between breeds, despite differences in total fat content and fat partitioning between breeds. In the perirenal depot in both breeds, growth occurred solely through cell enlargement whereas in the subcutaneous depot, which grew at a similar relative rate, considerable cell recruitment occurred, especially after 13 months of age. From these results it appears that fat deposition in the perirenal depot might eventually be limited by cell size whereas there seems to be no obvious limit to fat deposition imposed by cellularity in the subcutaneous depot.

This assumes, though, that further cell recruitment in the perirenal depot would not have occurred at heavier weights of fat such as occurred in the subcutaneous depot after 13 months of age. This is unlikely considering the high dry matter content of the perirenal depot compared with that of the subcutaneous. The lower dry matter content of the subcutaneous depot may reflect a larger stromal fraction from which recruitment can occur. This recruitment might be triggered by a particular adipocyte size as the large increase in recruitment occurred in both breeds at about the same average cell size. However, the same value of cell size was clearly not a universal trigger (i.e. in all depots).

The heavier weight of the perirenal depot in the Friesians was partly accounted for by larger cells and partly by more cells. However, since Friesians are a larger breed (i.e. have a greater mature body weight) they would be expected to have more adipocytes. In fact, perirenal adipocyte number per unit of fat-free body weight was estimated to be similar between the breeds ($15.1 \pm 0.6 \times 10^{12}$/kg vs $13.6 \pm 1.2 \times 10^{12}$/kg, for Friesians and Herefords, respectively), and so the observation of more perirenal cells in the Friesians is not remarkable. By the same token though, the observation that the Herefords had more subcutaneous adipocytes explains their greater weight of subcutaneous fat. It is probable that the differences found at 20 months would persist to maturity although this is not certain.

REFERENCES

HOOD, R.L. and ALLEN, C.E. 1973 Cellularity of bovine adipose tissue. J. Lipid Res. 14, 605-610.

WILLIAMS, D.R. 1978 Partition and distribution of fatty tissues. In Patterns of Growth and Development in Cattle (eds. H. De Boer and J. Martin) pp.219-230. Martinus Nijhoff, The Hague.

Fig. 1 Changes in ADIPOSE TISSUE WEIGHT with age

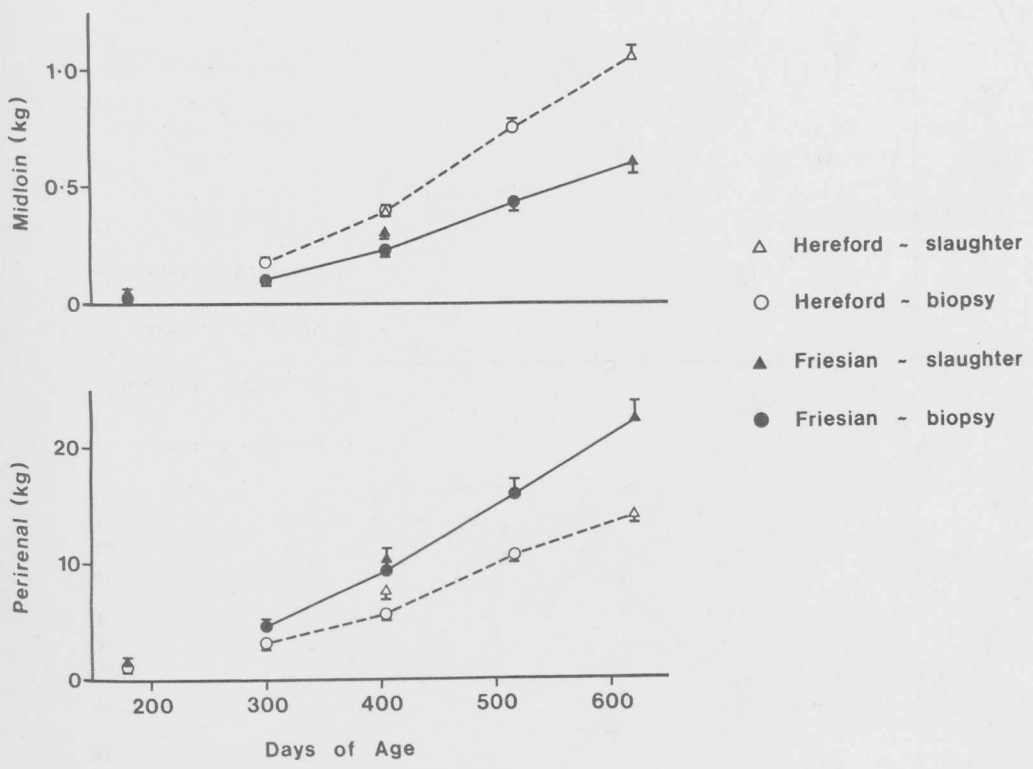

Fig. 2 Growth of relative midloin subcutaneous fat volume

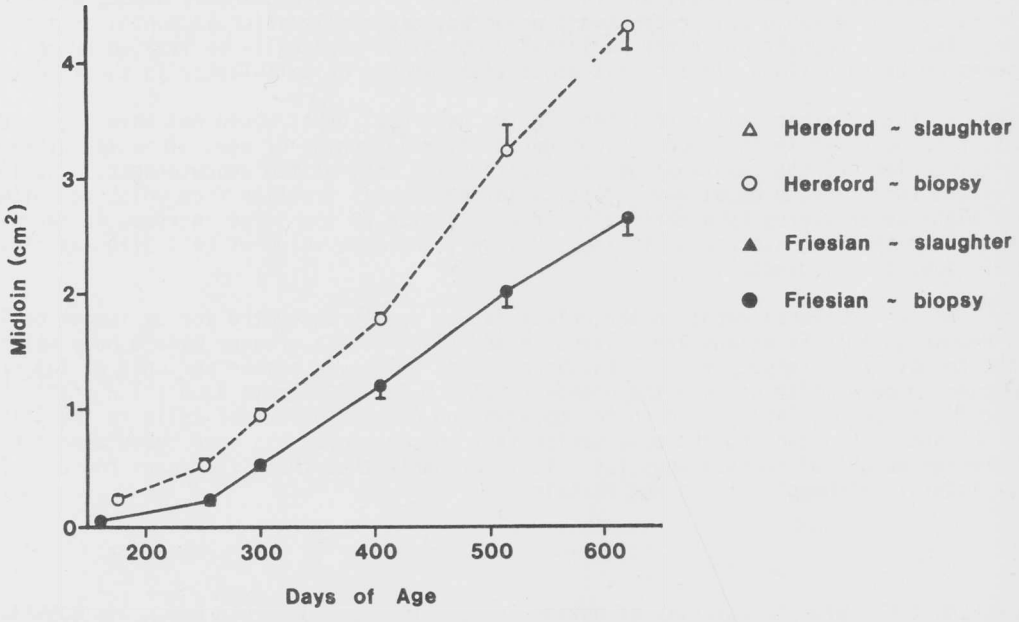

Fig. 3 Change in ADIPOCYTE VOLUME ($cm^3 \times 10^{-8}$) with age

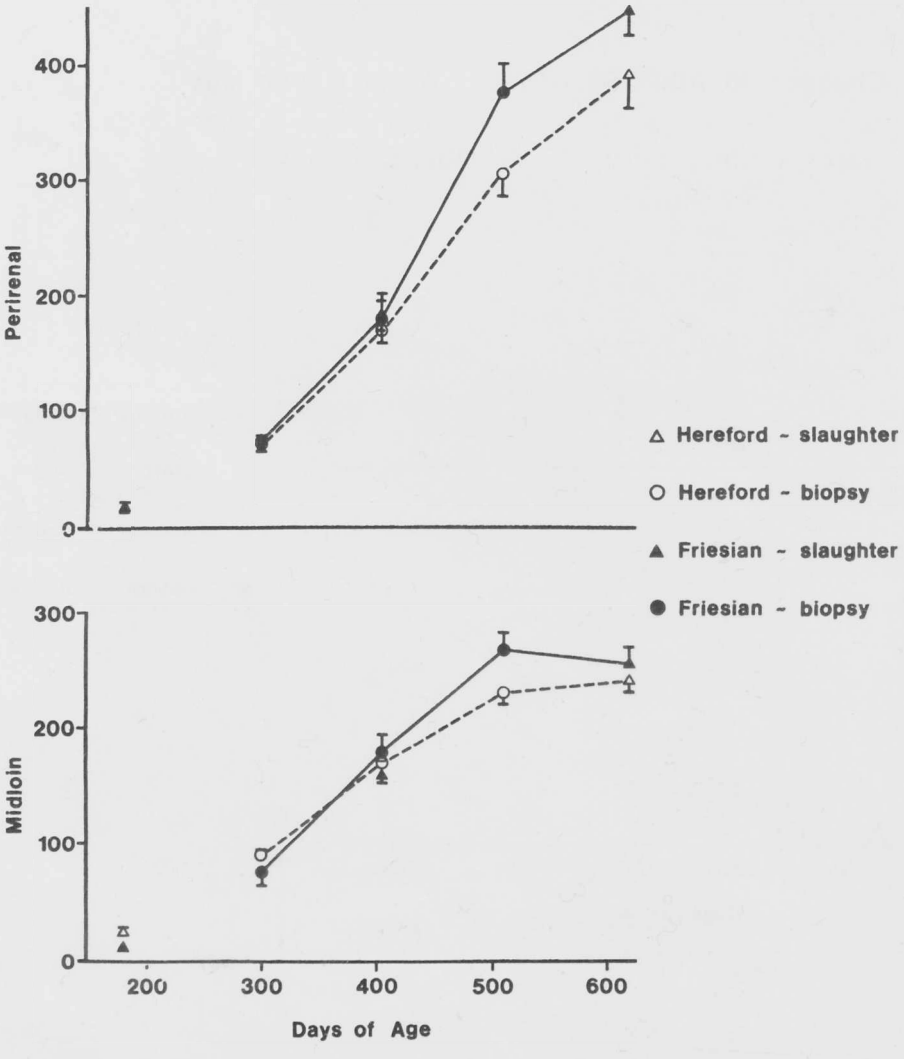

Fig. 4 Change in PERCENTAGE DRY MATTER with age

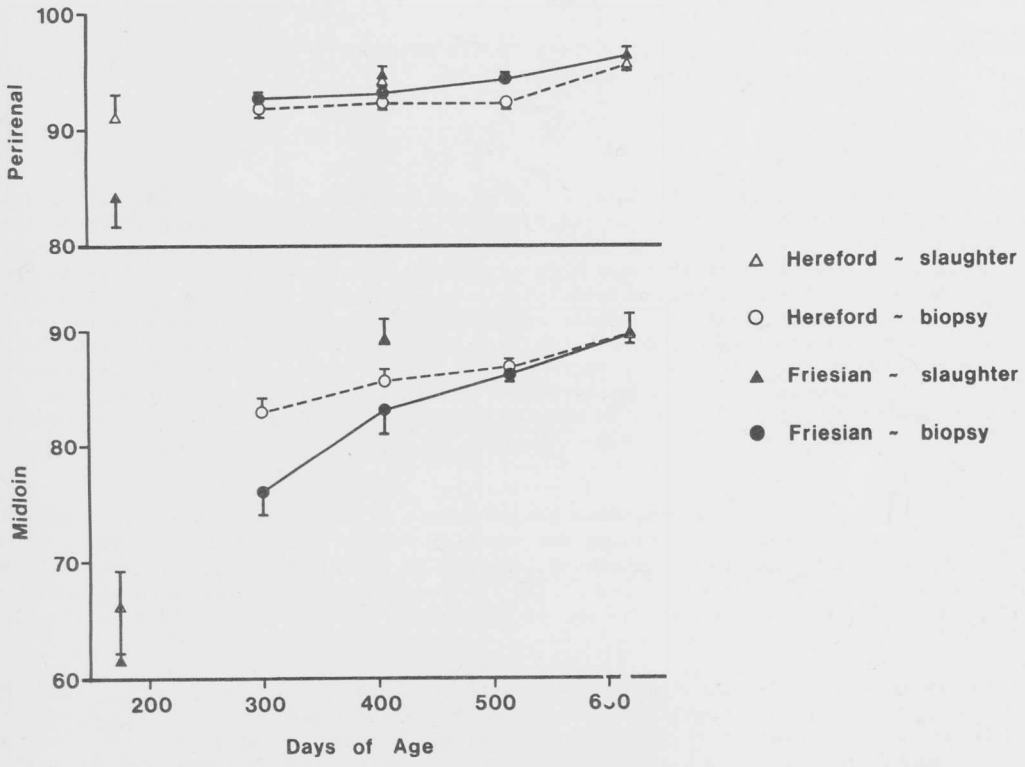

Fig. 5 Changes in ADIPOCYTE NUMBERS with age