ACCUMULATION OF LIPID IN RIB CUTS FROM BULL AND HEIFER CARCASSES OF TWO BREEDS

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A trial is reported comparing the accumulation of lipid in rib cuts from 12 bull and 12 heifer carcasses from two breed types: Hereford (HE) and Dairy Synthetic (DY). Serial slaughter was carried out from weaning (163 ± 15.1 (SD) days) to approximately 16 mo of age. The left side of each carcass was broken in two quarters, and then eight wholesale cuts. Fat samples (subcutaneous, intermuscular, body cavity) and a muscle sample were taken from the rib cut and analyzed for their lipid and energy contents. The rate of accumulation of lipid was estimated from the growth coefficient, b, in the allometric equation ($Y = aX^b$) using total separable fat as the independent variable. Growth coefficients were homogeneous both between breeds and sexes indicating that neither sex nor breed influenced the relative accumulation of lipid. A significant sex difference ($P < 0.01$) was found when the lipid content of the fat depots and the rib muscle were adjusted to a constant side separable fat. No breed differences ($P > 0.05$) were found in the lipid content of the fat depots. A significant difference between sexes was also found in the energy content of the fat depots, but no differences were found between breeds, when the data were adjusted to the mean of the total side fat.

Un essai a été réalisé pour comparer le mode d'accumulation des graisses dans le train de côtes de la carcasse de 12 taurillons et 12 génisses appartenant à deux types de race: Hereford et Synthétique laitier. On a procédé à l'abattage en succession à partir du sevrage (à 163 jours ± 15.1 ET) jusqu'à l'âge d'environ 16 mois. La moitié gauche de chaque carcasse a été séparée en deux quartiers, puis en huit morceaux de gros, et des échantillons de gras (sous-cutané, intermusculaire et splanchnique) et un échantillon de muscle ont été prélevés du train de côtes et analysés sur leur teneur en lipides et leur valeur énergétique. Le rythme d'accumulation des graisses a été calculé à partir du coefficient de croissance b dans l'équation allométrique $Y = aX^b$. Les coefficients de croissance étaient homogènes, quels que soient le sexe ou la race, ce qui montre qu'aucun de ces deux facteurs n'influait sur l'accumulation relative des graisses. On a cependant relevé une différence significative ($P < 0.01$) liée au sexe, lorsque la teneur en lipides des dépôts de graisse et celle du muscle des côtes étaient ajustées sur un poids constant (poids moyen) de graisses séparables par demi-carcasse. La race de l'animal n'a pas eu d'effet significatif (au seuil de 5%) sur la teneur en lipides des dépôts de gras. Pour ce qui est de la valeur calorique des dépôts, on a également trouvé une différence significative due au sexe, mais pas pour la race, quand les données étaient ajustées sur le poids moyen de graisse totale par demi-carcasse.

Recent studies investigating the accumulation of fat in beef cattle (Kempster et al. 1976; Berg et al. 1978) have been based on the physical separation of the carcass tissue. Few reports have examined the chemical

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composition of the fat depots, and it has been generally assumed that the accumulation of the chemical components directly relate to the physical mass of adipose tissue.

Genetic differences in fat depot composition might possibly be largest when cattle of a different type are compared. The present study reports on the composition and energy content of the fat depots in bulls and heifers of both beef and dairy type.

MATERIALS AND METHODS

The experiment was conducted at the University of Alberta Research Ranch at Kinsella using bulls and heifers of two breed types, Hereford (HE) and Dairy Synthetic (DY). The experimental procedure has recently been outlined in detail by Jones et al. (1980). Briefly, 12 bulls and 12 heifers of each breed were serially slaughtered in random order over a wide age range (155–465 days). The left side of each carcass was quartered and broken into eight wholesale cuts as outlined by Levie (1970) except that it was quartered between the 11th and 12th ribs. The plate and brisket were also combined as one cut. The cuts were separated into muscle, subcutaneous fat (SF), intermuscular fat (IF), body cavity fat (BCF) and bone. The muscle from the rib cut was ground twice through a 0.63-cm plate, and then homogenized for 20 sec in a Hobart mixer. Duplicate samples of 200 g were removed, placed in polyethylene bags and stored at −18°C. The same procedure was used for SF, IF and BCF except that dry ice was added to facilitate the grinding and homogenization of the fat samples. The samples were later thawed at room temperature, freeze-dried, and the lipid estimated by the chloroform-water-methanol solvent system similar to that reported by Atkinson et al. (1972). A 2.0-g muscle sample or a 1.5-g fat sample was placed in a methylation tube. Ten millilitres of chloroform (non-distilled and adjust volume for 2% ethanol) and 18.9 mL methanol:water were added to the sample and the mixture homogenized with a polytron for 30 sec, followed by centrifugation at 2000 rpm for 4 min. Five millilitres of the chloroform was removed with a calibrated syringe, and evaporated in an aluminum dish. The extracted lipid was then weighed. Percentage lipid in a sample was calculated from the equation given below

$$\% \text{ lipid} = \frac{Vc \times Wz}{(Vz - (Vt \times Wz) \times Ss)} \times 100$$

where Vc = volume of chloroform, Wz = weight of extracted lipid, Vz = volume of subsample, Vt = volume of 1 g of lipid dissolved in chloroform (0.86) and Ws = weight of the sample. The energy contents of the extracted lipids were determined in a bomb calorimeter.

The 'growth coefficients' of lipid and energy from the samples relative to total side fat weight were calculated using the logarithmic form of Huxley's allometric equation ($Y = aX^b$). If the individual regressions for breed and sex were homogeneous, a common slope was fitted and group means were compared after adjusting to a common side fat weight. Differences among adjusted means were established by the Scheffé test using a technique for unequal subclass numbers (Neter and Wasserman 1974).

RESULTS AND DISCUSSION

The accumulation of lipid in the rib cut and the fat depots relative to total side fat is shown in Table 1. The individual regressions for each breed-type and sex were homogeneous for each depot, so the common regression coefficient was used. The growth coefficients indicated that as total side fat increased, lipid accumulation was greatest in the rib cut muscle followed by the SF, IF and BCF depots.

Although there are no other studies with which to compare these growth coefficients, it has commonly been stated that intramuscular fat (marbling fat), is the latest depot to develop (Lawrie 1974). The lipid accumulation patterns followed a gradient from within the carcass (BCF) to the outer layer (SF) and finally to within the muscle itself. This order of depot fat development agrees with the physical pressure hypothesis suggested by Berg and Butterfield (1976).

There were no breed differences in the proportion of lipid contained in the fat depots. Subcutaneous fat and BCF contained approximately 70% lipid, which agrees closely with the results of Callow (1962), and is similar to those of Reid (1972). Intermuscular fat contained approximately 63% fat which was less than that found by the previous reports (Callow 1962; Reid 1972). Breed-type had no effect in this study on the proportion of lipid in the rib cut muscle.

Table 1. Accumulation of lipid relative to total fat (physical separation), and the lipid in the fat depots in the rib cut adjusted to the mean of total fat (18.13 kg)

			% lipid					
			Breed			Sex		
Dependent variable	Regression coefficient	±SE	Hereford	Dairy Synthetic†	Difference	Female	Male	Difference
Subcutaneous fat	0.21	0.018	70.2	69.7	0.5	72.9	67.1	5.8***
Intermuscular fat	0.16	0.013	63.7	63.1	0.6	66.6	60.4	6.2***
Body cavity fat	0.15	0.011	72.3	72.1	0.2	74.7	69.8	4.9***
Rib cut muscle	0.41	0.38	8.2	8.1	0.1	9.6	6.9	2.7***

†Dairy Synthetic = composite averaging 30% Holstein, 30% Brown Swiss, and 40% other breeds.
***$P < 0.001$.

Lawrie (1974) found breed differences in the proportion of lipid in different cuts of muscle, but the lipid contents of the fat depots were not adjusted to a constant weight of adipose tissue.

There were highly significant differences between sexes in the proportion of lipid in the fat depots and the rib cut muscle (Table 1). Heifers contained more lipid in all the fat depots and the rib cut muscle. At the same side fat weight, heifers were possibly further along the fattening pathway than bulls, and thus contained more lipid and less water in the fat depots.

The accumulation of energy in the rib cut and the fat depots relative to total side fat is shown in Table 2. The individual regressions for each breed-type and sex were homogeneous for each depot, so the common regression coefficient was used. Relative to total side fat, energy accumulation was greatest in the SF depot and the rib cut muscle and least in the BCF depot.

There was no breed difference in the energy content of the depot fat. However, heifers had fat depots and muscle with higher energy contents than bulls simply as a result of a greater lipid content. These results directly agree with those already presented for the lipid content of the fat depots (Table 1).

These results have application to many published carcass studies. Most of these reports have assumed that physically separable adipose tissue from the same location of a carcass has the same chemical composition regardless of breed, sex and nutritional background. These results suggest that while this may be true in this study for breed comparisons, the same is not true when the two sexes are compared. Some caution must be applied when evaluating

Table 2. Accumulation of energy (kJ) relative to total fat (physical separation), and the energy content of the fat depots in the rib cut adjusted to the mean total fat (18.13 kg)

			Energy (kJ/g tissue)					
			Breed			Sex		
Dependent variable	Regression coefficient	±SE	Hereford	Dairy Synthetic†	Difference	Female	Male	Difference
Subcutaneous fat	0.12	0.007	31.27	31.21	0.06	32.09	30.42	1.67***
Intermuscular fat	0.10	0.007	28.47	28.14	0.33	29.33	27.29	2.04***
Body cavity fat	0.08	0.005	31.76	31.60	0.16	32.35	31.02	1.33***
Rib cut muscle	0.12	0.012	11.60	11.45	0.15	11.94	11.13	0.81**

†Dairy Synthetic = composite averaging 30% Holstein, 30% Brown Swiss, and 40% other breeds.
**$P < 0.01$; ***$P < 0.001$.

these results, as only one cut (rib) was used to determine the lipid content of fat depots. Further work needs to be carried out to investigate the composition of all the wholesale cuts.

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