FATTENING PATTERNS IN CATTLE. 2. FAT DISTRIBUTION AMONG THE WHOLESALE CUTS

S. D. M. JONES[1], M. A. PRICE, and R. T. BERG

Department of Animal Science, University of Alberta, Edmonton, Alta. T6G 2H1.
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A trial is reported comparing fat distribution in carcasses from bulls and heifers of two breed-types: Hereford (HE) and Dairy Synthetic (DY). Twelve bulls and twelve heifers of each breed were grouped four to a pen at weaning (163 ± 15.1 (SE) days), and serially slaughtered from that time to approximately 16 mo of age. After slaughter, one side of each carcass was broken into eight wholesale cuts, which were separated into fat (subcutaneous fat (SF), intermuscular fat (IF), and body cavity fat (BCF)), muscle and bone. Depot fat accretion in each cut was investigated using the allometric equation with side fat weight as the independent variable. Coefficients for SF were significantly higher in the rib, chuck and flank for HE carcasses than for DY carcasses and higher in the rib and flank for heifers than for bulls. At equal total side fat, HE carcasses had significantly more SF in the brisket and in the loin than DY animals. Heifers had significantly more fat in the loin than bulls. Differences among coefficients for IF relative to total fat were minor for both breed and sex. At equal total side fat, HE carcasses had less fat distributed intermuscularly than DY carcasses and had less IF in the brisket than heifers. The results are discussed in relation to the Canadian beef grading system.

Une expérience a été réalisée sur 12 taurillons et 12 génisses appartenant à deux types de races. Les bêtes ont été abattues à dates successives à partir du sevrage jusqu'à l'âge de 16 mois et chaque demi-carcasse a été découpée en huit morceaux de gros dont on a séparé les graisses, les muscles et les os. Le taux d'accroissement des graisses de dépôt dans chaque morceau a été calculé à partir de l'équation allométrique, utilisant le poids de graisse de la demi-carcasse comme variable indépendante. Les coefficients obtenus pour SF (graisse sous-cutanée) étaient significativement plus élevés dans la côte, le bloc (épaule) et le flanc chez les carcasses de type Hereford (HE) que chez celles de type laitier (DY). De même, ils étaient plus élevés dans la côte et le flanc chez les génisses que chez les taurillons. Ramenées à un poids constant de graisse totale, les carcasses HE révélaient significativement plus de SF dans la pointe de poitrine et dans la longe que les carcasses DY. La longe des génisses était significativement plus grasse que celle des taurillons. Les deux races et les deux sexes ont produit des coefficients sensiblement homogènes pour IF (graisse intermusculaire). Ramenées à un poids constant de graisse totale, les carcasses HE avaient moins de graisse intermusculaire que les DY et les taurillons moins de IF dans la pointe de poitrine que les génisses. Les auteurs discutent les résultats en regard du système canadien de classement du boeuf.

Beef carcass value is determined mainly by the amount and distribution of the carcass tissues. Muscle and bone distribution have been shown to have little between breed variation within sex and weight groups (Berg

[1]Present address (S.D.M.J.): Department of Animal and Poultry Science, University of Guelph, Guelph, Ontario N1G 2W1.

et al. 1978a,b), since relatively fixed proportions of these tissues are thought necessary to ensure function. Fat has no such apparent functional demands on it as a tissue, and so might not be expected to follow such an orderly distribution as the other tissues. Small genetic differences in fat distribution have been shown by several workers (Kempster et al. 1976; Berg et al. 1978c), but these have not really been considered to be of commercial importance. The previous paper in this series (Jones et al. 1980b) showed breed effects, but no sex effects on the partition of fat among the depots. There is little work in the literature comparing fat distribution in carcasses from animals having beef and dairy conformation. This paper examines the distribution of fat among the wholesale cuts in bulls and heifers of beef and dairy types.

MATERIAL 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 design has recently been discussed in detail (Jones et al. 1980a,b). Briefly, 24 bulls and 24 heifers were grouped four to a pen by breed-type within sex, fed a high concentrate diet and serially slaughtered. Age at slaughter ranged from 6 to 16 mo.

Following slaughter, the left side of each carcass was taken to the University of Alberta Meat Laboratory where it was broken into eight wholesale cuts at outlined by Levie (1970), except that the carcasses were quartered between the 11th and 12th ribs. The plate was included as part of the brisket. The eight cuts (chuck, shank, rib, brisket, loin, flank, sirloin, hip) were separated into muscle, subcutaneous fat (SF), intermuscular fat (IF), body cavity fat (BCF) and bone.

The growth of the fat depots in each cut was assessed relative to the weight of total side fat using the allometric equation. Growth coefficients and adjusted means were compared as outlined by Jones et al. (1980a,b).

RESULTS AND DISCUSSION

The mean unadjusted fat weights (total, SF and IF) in each wholesale cut are presented in Table 1. The brisket and chuck had the greatest weight of dissected fat in the forequarter, while the flank had the greatest weight of dissected fat in the hindquarter.

The growth of SF in each cut relative to total fat is shown in Table 2. Relative SF growth was significantly higher in the rib, chuck and flank cuts for HE animals than for DY animals, and higher in the rib and flank cuts for heifers than for bulls. These differences in coefficients suggest minor breed and sex effects on the relative growth of SF which follow no fixed pattern, and are similar to those found by Berg et al. (1978c).

Differential fat growth has been reported in a number of recent studies (Seebeck and Tulloh 1968; Kempster et al. 1976; Berg et al. 1978c), which generally showed that the growth impetus for total fat in a cut was lowest in the limbs, neck and rump regions, increasing to a high impetus in the mid-back region. The growth of SF for each cut in this study followed a similar pattern, although there are few other published results for comparison. Differential fat growth has not been adequately explained. It may be simply a case of the depots with superior vascular supply being filled preferentially, and then modified by the local pressures within depots (Berg and Butterfield 1976), or breed differences in the number and potential size of the adipocytes (Hood and Allen 1973).

The weight of SF in each cut adjusted to the overall mean for total side fat for both breeds and sexes is shown in Table 3. The interactions. for breed and sex were not significant ($P > 0.05$). HE animals had significantly more SF in the brisket and in the loin than DY animals. Heifers had significantly more fat in the loin than bulls.

The previous report in this series (Jones et al. 1980b) demonstrated that HE animals partitioned more of their fat subcutaneously than DY animals, which supported the earlier work of Callow (1961). The present study suggests that these breed differences in partitioning cause differences in fat distribution, particularly in the loin and brisket. Although these differences are not large

Table 1. Means (kg ± SD) of unadjusted fat weights in each cut by breed and sex

	Breed				Sex			
Cuts No. of animals:	Hereford 23	SD	Dairy Synthetic† 24	SD	Heifer 24	SD	Bull 23	SD
Forequarter								
Shank								
Total fat	0.65	0.323	0.58	0.231	0.60	0.287	0.63	0.275
Subcutaneous fat	0.31	0.217	0.28	0.160	0.28	0.175	0.31	0.206
Intermuscular fat	0.33	0.157	0.30	0.104	0.31	0.136	0.32	0.129
Brisket								
Total fat	4.11	2.513	4.10	2.037	4.36	2.365	3.84	2.159
Subcutaneous fat	1.08	0.765	0.89	0.525	1.06	0.695	0.90	0.612
Intermuscular fat	2.35	1.394	2.54	1.342	2.57	1.341	2.33	1.392
Rib								
Total fat	3.08	2.275	3.17	2.042	3.23	2.155	2.99	2.158
Subcutaneous fat	1.14	0.853	0.99	0.713	1.16	0.808	0.98	0.756
Intermuscular fat	1.48	1.102	1.68	1.086	1.63	1.077	1.54	1.119
Chuck								
Total fat	4.03	2.608	4.24	2.307	4.07	2.427	4.21	2.494
Subcutaneous fat	1.00	0.766	0.76	0.414	0.93	0.621	0.82	0.624
Intermuscular fat	2.77	1.738	3.07	1.622	2.78	1.606	3.07	1.754
Hindquarter								
Flank								
Total fat	3.95	2.460	4.28	2.668	4.13	2.534	4.10	2.616
Subcutaneous fat	2.28	1.477	2.31	1.482	2.31	1.432	2.29	1.526
Intermuscular fat	0.63	0.409	0.64	0.391	0.64	0.363	0.62	0.435
Sirloin								
Total fat	0.95	0.602	0.99	0.539	0.97	0.542	0.97	0.599
Subcutaneous fat	0.37	0.238	0.37	0.262	0.37	0.230	0.37	0.270
Intermuscular fat	0.49	0.294	0.49	0.267	0.49	0.276	0.48	0.285
Loin								
Total fat	3.14	2.398	2.80	1.568	3.19	2.184	2.73	1.812
Subcutaneous fat	1.54	1.309	1.16	0.902	1.50	1.193	1.18	1.049
Intermuscular fat	0.55	0.399	0.58	0.281	0.60	0.395	0.53	0.278
Round								
Total fat	2.80	1.483	2.85	1.365	2.65	1.298	3.02	1.520
Subcutaneous fat	1.32	0.859	1.26	0.716	1.20	0.715	1.37	0.853
Intermuscular fat	1.35	0.616	1.46	0.652	1.31	0.573	1.51	0.682

†Dairy Synthetic = composite averaging 30% Holstein, 30% Brown Swiss, and 40% other breeds.
The difference between the sum of subcutaneous and intermuscular fat and total fat in a wholesale cut is made up by the body cavity fat.

Table 2. Estimates from the allometric relationship $Y = aX^b$ of subcutaneous fat in a cut (Y) with total fat in a side (X) for two breeds and two sexes

Dependent variable (Y)	Breed growth coefficient b				Effect of breed on slope	Sex growth coefficient b				Effect of sex on slope
	Hereford	SEb	Dairy Synthetic†	SEb		Heifer	SEb	Bull	SEb	
Forequarter										
Shank	1.32	0.152	1.00	0.203	NS	1.36	0.155	0.98	0.190	NS
Brisket	1.07	0.071	0.96	0.096	NS	1.08	0.074	0.95	0.090	NS
Rib	1.82	0.121	1.28	0.162	*	1.88	0.120	1.24	0.147	*
Chuck	1.36	0.083	0.98	0.111	*	1.28	0.092	1.13	0.113	NS
Hindquarter										
Flank	1.16	0.041	0.99	0.055	*	1.17	0.042	0.99	0.052	*
Sirloin	1.00	0.081	1.07	0.109	NS	1.00	0.084	1.06	0.103	NS
Loin	1.38	0.036	1.32	0.048	NS	1.36	0.037	1.37	0.046	NS
Round	0.84	0.058	0.91	0.078	NS	0.81	0.059	0.94	0.073	NS

†Dairy Synthetic = composite averaging 30% Holstein, 30% Brown Swiss, and 40% other breeds.
NS, $P > 0.05$, $*P < 0.05$.

(0.24 kg in the loin and 0.13 kg in the brisket) and may not have importance in the retail trade, they could influence the accuracy of the Canadian beef grading system. The same average fat thickness measured at the cut surface of the 12th rib in HE and DY carcasses may not result in carcasses of equal fatness. This may be true of beef and dairy-type carcasses generally.

Sex differences in fat distribution were also recorded and heifers had more fat in the loin than bulls. Thus, the same argument could be applied to that above, as at the same minimum fat thickness bulls would be fatter than heifers.

The accumulation of IF in each cut relative to total fat is shown in Table 4. IF growth showed only minor differences for breed (DY higher than HE for the rib cut) and sex (bulls higher than heifers for the chuck cut).

The coefficients for IF were generally lower than those found for SF which has been a general result of most carcass studies. Differential growth of IF appeared to follow a path similar to that found for SF. The lowest coefficients were found in the limbs, and highest coefficients in the rib and flank.

The adjusted weights of IF in each cut adjusted to the mean of total side fat for both breeds and sexes are shown in Table 5. The breed × sex interactions were not significant ($P > 0.05$). DY animals had significantly more fat deposited intermuscularly than HE animals in the chuck cut. Bulls had significantly more IF in the chuck and round cuts, and less IF in the brisket than heifers. Intermuscular fat distribution has practical importance in that is is more expensive to trim in retail cuts than subcutaneous fat.

The results of the present trial indicate that fat distribution is influenced by breed and sex, although the actual differences recorded were not large. Traditional beef breeds such as the Hereford have been selected over many generations for "beef conformation" and shape has no doubt changed. Muscle and bone distribution show little variation and this infers that breeders have had some minor success in changing fat distribution. Dairy cattle have also been selected over many generations for milk production and "dairy character."

The current knowledge on fat growth and distribution is still far from complete. It is unclear if environmental effects (e.g. nutrition and temperature) modify the partition and distribution of fat in cattle. These factors will require study before models can be developed to predict carcass fat.

Table 3. Subcutaneous fat weights (kg) in each cut adjusted to the mean of total side fat weights (18.48 kg) for the two breeds and two sexes

	Fat weight (kg)					
	Hereford	Dairy Synthetic†	Difference	Heifer	Bull	Difference
Forequarter						
Shank	0.22	0.21	0.01	0.20	0.23	0.03
Brisket	0.82	0.69	0.13*	0.79	0.72	0.07
Rib	0.71	0.68	0.03	0.68	0.71	0.03
Chuck	0.69	0.59	0.10	0.66	0.62	0.04
Hindquarter						
Flank	1.77	1.80	0.03	1.73	1.84	0.11
Sirloin	0.29	0.28	0.01	0.29	0.28	0.01
Loin	1.03	0.79	0.24*	1.00	0.81	0.19*
Round	1.10	1.02	0.08	0.99	1.13	0.14

†Dairy Synthetic = composite averaging 30% Holstein, 30% Brown Swiss, and 40% other breeds.
$*P < 0.05$.

Table 4. Estimates from the allometric relationship $Y = aX^b$ of intermuscular fat in a cut (IY) with total fat in the side (X) for two breeds and two sexes

Dependent variable (Y)	Breed growth coefficient b				Effect of breed on slope	Sex growth coefficient b				Effect of breed on slope
	Hereford	SEb	Dairy Synthetic†	SEb		Heifer	SEb	Bull	SEb	
Forequarter										
Shank	0.57	0.071	0.45	0.094	NS	0.55	0.074	0.49	0.090	NS
Brisket	0.94	0.038	1.05	0.051	NS	0.94	0.039	1.04	0.049	NS
Rib	1.16	0.035	1.29	0.046	*	1.18	0.037	1.25	0.046	NS
Chuck	0.94	0.029	0.99	0.039	NS	0.90	0.029	1.01	0.036	*
Hindquarter										
Flank	1.11	0.082	1.22	0.110	NS	1.10	0.085	1.23	0.104	NS
Sirloin	0.81	0.115	0.73	0.154	NS	0.75	0.119	0.82	0.146	NS
Loin	0.85	0.082	0.65	0.109	NS	0.85	0.086	0.70	0.105	NS
Round	0.77	0.035	0.73	0.047	NS	0.79	0.036	0.71	0.044	NS

†Dairy Synthetic = composite averaging 30% Holstein, 30% Brown Swiss, and 40% other breeds.
NS, $P > 0.05$, $*P < 0.05$.

Table 5. Intermuscular fat weights (kg) in each cut adjusted to the mean of total side fat weight (18.48 kg) for the two breeds and two sexes

	Fat weight (kg)					
	Hereford	Dairy Synthetic†	Difference	Heifer	Bull	Difference
Forequarter						
Shank	0.30	0.27	0.03	0.28	0.29	0.01
Brisket	1.96	2.01	0.05	2.09	1.88	0.21*
Rib	1.11	1.21	0.10	1.19	1.13	0.06
Chuck	2.30	2.47	0.17*	2.26	2.51	0.25*
Hindquarter						
Flank	0.48	0.46	0.02	0.49	0.46	0.03
Sirloin	0.41	0.38	0.03	0.41	0.38	0.03
Loin	0.44	0.49	0.05	0.47	0.46	0.01
Round	1.21	1.26	0.05	1.13	1.35	0.22*

†Dairy Synthetic = composite averaging 30% Holstein, 30% Brown Swiss, and 40% other breeds.
*$P < 0.05$.

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