CARCASS COMPOSITION OF CATTLE OF CENTRAL EUROPE

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Slaughter traits of cattle have received considerable attention. In addition to killing out percentage it was, historically at least, mainly the distribution of meat in cuts of different value and measurements of fat percentage that received much attention. It was implicitly assumed, at least in the concept of chemical maturity of Moulton, Trowbridge, and Haigh (1922), that the fat-free body displays no variation in composition. Only fairly recently, in the wake of the publication of Berg and Butterfield's book on growth of the bovine body, has the proportion of the major tissues meat, fat, and bone received much attention.

At our department we have conducted two experiments with the intention of studying the slaughter traits of Central European cattle.

EXPERIMENTAL PROCEDURE

In Experiment 1 male twins were purchased from farmers and either fattened as veal or fattened as bulls. The twin pairs were either split, and one twin treated as veal calf and the other as bull, or the two twins were treated uniformly. Veal calves were fattened on milk replacer and killed when they reached 38 per cent of the estimated adult weight of the respective breed. Bulls were weaned early and grown on silage, roughage, and concentrate to equal finish at about one year of age (Table 1).

Table 1: Plan of Experiment 1

	Brown Alpine	Fleckvieh	Greys	Pinzgauer	Friesians
Twin pairs	11	9	9	9	6
Distribution of pairs					
M-M	3	2	2	2	1
J-J	2	2	2	2	1
J-M	6	5	5	5	4
Number animals at end of experiment	21	17	17	17	11

M-M = both animals veal; J-J = both animals yearling bulls; J-M = one animal veal, one animal yearling bull.

In Experiment 2 bull calves were bought from farmers and grown at either 80 or 120 per cent of recommended allowance to various multiples of birthweights (Table 2). Effects of four breeds, four slaughter weights, and two feeding intensities were investigated in a 4 x 4 x 2 factorial design. It was replicated three times; therefore, ninety-six animals were involved in the experiment.

Table 2: Plan and slaughter weights (kg) of Experiment 2

	Multiples of Birthweight				
	2x	4x	6x	10x	Mean
Breed					
FV	101.5[1]	199.3	290.8	423.8[2]	253.9[5]
Pi	96.8	192.7	280.8	447.5	254.5
Sb	90.5	171.8	253.8	410.3	231.6
J	46.3	81.8	125.3	211.8	116.3
Mean	83.8[4]	161.4	237.7	373.3	
Feeding Level					
80%	208.6[3]				
120%	219.5				

Errors of mean: [1] = 1.86; [2] = 2.28; [3] = 0.70; [4] = 0.93; [5] = 0.99

FV = Fleckvieh; Pi = Pinzgauer; Sb = Friesians; J = Jerseys.

RESULTS

The tissue composition of the carcasses of Experiments 1 and 2 is shown in Tables 3 and 4 and Figure 1. By and large they conform to expectation. Increasing weights and increasing age are accompanied by increase in the meat: bone ratio and by a greater percentage of carcass fat. The dual-purpose Breeds Fleckvieh (FV), Brown Alpine (BV), and Grey (GV) in Experiment 1 and Fleckvieh in Experiment 2 have the highest meat : bone ratio. The Pinzgauer (Pi) in both experiments follow this group and Friesians (Sb), and in particular Jerseys (J), trail the list in meat : bone ratio. Carcass fat percentage is highest in the Friesians of Experiment 1 but the Greys are second; in Experiment 2 the Jerseys have least fat. In general the conclusion is that the dual-purpose breeds originating from the western Alpine region have more meat and less fat and bone and the dairy breeds have more fat and bone and less meat. This trend increases with increasing dairy potential. There are two reasons to account for the high fat percentage of the Greys in Experiment 1: (1) they are a small breed; (2) insufficient accuracy in estimating the degree of finish on the live animal. The low carcass fat percentage of the Jerseys in Experiment 2 is difficult to explain by the hypothesis assumed. The Pinzgauer is a more longitudinal breed where the meat : bone ratio is somewhat less than in the heavier-muscled dual-purpose breeds.

Table 3: Means and residual variances of daily gain, tissue proportions, and carcass gain

	N	*Daily Gain (kg/day)*	*Weight of Half Carcass (kg)*	*Meat %*	*Fat %*	*Bone %*	*Tendon %*	*Carcass Gain (g)*
μ	83	1.009	80.2	77.81	6.43	19.52	2.73	774
Breed		*		*		*	*	
BV	21	1.129	79.4	78.62	6.04	18.80	2.61	796
FV	17	1.211	80.5	77.76	6.08	19.56	2.72	819
GV	17	1.083	77.6	79.52	6.70	17.97	2.53	770
Pi	17	1.098	78.5	77.08	6.09	19.98	3.02	766
Sb	11	0.974	84.8	76.04	7.23	21.31	2.76	720
Fattening Method		*	*	*	*	*	*	
M.	43	1.195	41.6	76.32	5.80	20.88	2.86	776
J.	40	1.003	118.8	79.29	7.55	18.17	2.60	772
σ^2_R		0.012	49.96	1.13	2.02	1.11	0.17	776

* highly significant ($p < 0.01$)

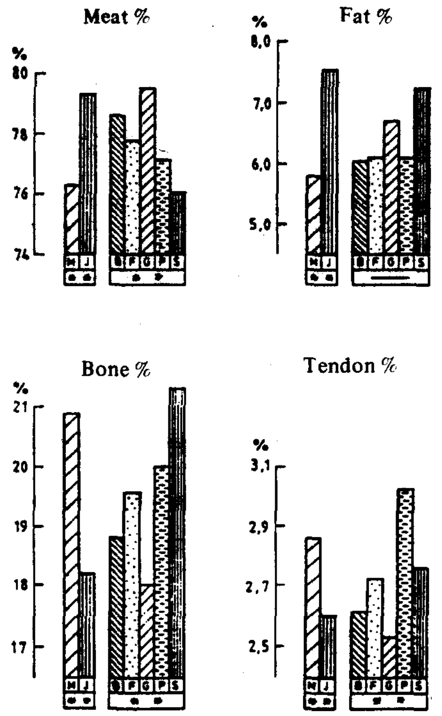
Table 4: Meat Percentage and Meat : Bone Ratio – Experiment 2

	Multiples of Birthweight						
			Meat %				
	2x	4x	6x	10x	Mean		
Breed							
FV	68.9[1]	71.8	72.6	73.1[2]	71.6		
Pi	69.1	68.2	69.9	71.5	69.7	*Feeding Level*	
Sb	68.2	68.4	70.1	70.6	69.4	80%	69.4[3]
J	66.5	66.2	65.4	70.1	67.1[5]	120%	69.5
Mean	68.2[4]	68.6	69.5	71.3			

Errors of mean: [1] = .74; [2] = .90; [3] = .28; [4] = .37; [5] = .39.

			Meat : Bone Ratio		Mean		
Breed							
FV	3.06[1]	3.51	3.94	4.56[2]	3.77		
Pi	2.99	3.16	3.43	4.07	3.41	*Feeding Level*	
Sb	2.86	2.91	3.37	3.93	3.27	80%	3.25[3]
J	2.56	2.74	2.60	3.46	2.84[5]	120%	3.39
Mean	2.87	3.08	3.34	4.01[4]			

Errors of mean: [1] = .11; [2] = .14; [3] = .04; [4] = .06; [5] = .06.



M = veal; J = yearling bull; B = BV; F = FV; G = GV; P = Pi; S = Friesian; * = significant ($p < 0.05$); ** = highly significant ($p < 0.01$); – = not significant.

Figure 1: Tissue proportions of carcasses of five breeds and two fattening methods

The growth-rates of the animals of Experiment 1 are also given in Table 3 and illustrated in Figure 2, together with carcass gain. In Experiment 1 feeding was controlled and feed efficiency could be calculated. In Table 5 the food conversion rates (FCR) are given and confirm the trend indicated by carcass composition data. It is interesting to note that no interaction between breeds and fattening method/slaughter age exists. This appears to be remarkable since veal-fattening involves 'non-ruminant' digestion, which is contrasted in this experiment with regular fattening of growing ruminants.

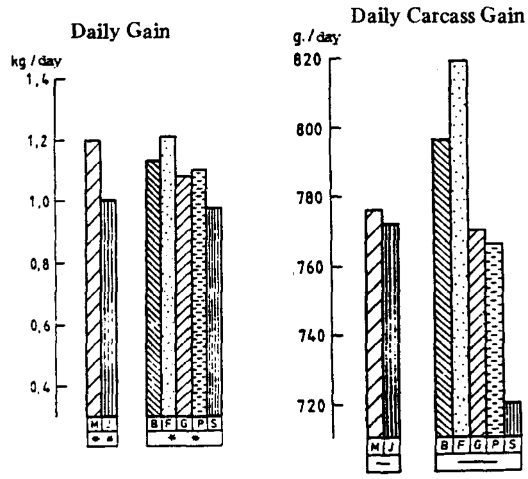


Figure 2: Daily liveweight gain and daily carcass gain of five breeds and two fattening methods

Table 5: Food conversion rate

	MM*	43	1.38 1.39	1.32 1.33	1.31 1.31	1.36 1.36	1.63 1.62	1.40 1.40
kg starch value/kg gain	JS†	40	2.98 3.01	3.01 3.03	2.82 2.80	2.99 3.01	3.17 3.11	2.99 2.99
	0	83	2.18 2.20	2.16 2.18	2.06 2.05	2.17 2.19	2.40 2.37	2.20 2.20

	Significance	F-value	Significance	F-value
Breeds	**	5.27	**	4.53
Fattening	**	1371.93	**	1372.69
Interaction	–	0.57	–	1.00

* MM = veal; † JS = yearling bulls.
First line corrected to mean carcass fat of breed group.
Second line MM corrected to 5.6% carcass fat, JS to 8.2% carcass fat.

In Experiment 1 the carcass was divided into commercial cuts while in Experiment 2 muscles were dissected.

Table 6 gives percentage of some cuts that appeared to be of interest. The Friesians seem to have relatively more meat in brisket and fore-rib; least of the five breeds in the fillet and striploin; and rather less than the average of the other breeds in the rear quarter. However, interaction breed x fattening methods exists for percentage of meat in the striploin and in the hindquarter. While Friesian veal calves have large hindquarter proportions and also heavy striploins the Friesian bulls fall away and score last. Together with the Pinzgauer, Friesians have relatively heavy shin muscles.

Table 6: Distribution of meat in commercial cuts

	Breed	*Brisket %*	*Fore-Rib %*	*Fore Shin %*	*Hind Shin %*
	BV	5.1	5.6	3.6	5.9
I	FV	5.8	5.6	3.5	5.9
	GV	5.6	5.8	3.3	5.5
	Pi	5.6	5.6	3.8	6.0
	Sb	5.9	6.0	3.6	6.0
	MM	5.4	5.6	3.9	6.7
	JS	5.8	5.9	3.2	5.1
	σ^2_R	0.20	0.11	0.08	0.15

		Striploin %		*Hindquarter %*		*Butt %*	
		MM	JS	MM	JS	MM	JS
II	BV	12	12.2	30.6	28.3	5.9	6
	FV	12.5	11.9	31.9	28.5	6.1	5.8
	GV	12.2	12.0	30.8	28.6	5.6	5.8
	Pi	11.5	11.9	30.2	27.6	5.9	5.8
	Sb	11.2	12.0	32.1	27.6	6.4	5.7
	σ^2_R	0.29		0.79		0.13	

I Interaction (breed x fattening method) mean square statistically significant.
II Interaction (breed x fattening method) mean square not significant.
n. animals 83, distribution fairly balanced
MM = killed as veal calf, at 38% of adult weight; JS = killed as yearling bull, at comparable finish; σ^2_R = residual mean square, 73 df.

In Experiment 2 eighteen muscles were dissected. For most muscles the influence of weight and breed is statistically significant or even highly significant. However, if F values (Table 7) are compared with those relating the influence of weight and breed on tissue percentage, it is obvious that muscle distribution is much less affected by breed and stage of development than are tissue percentages. This is further illustrated by the range of muscle percentage and of meat:bone ratio between breeds. The difference between the most extreme muscle percentage is 1.06 s while FV and J differ in meat:bone ratio by 3.36 s. The muscle percentages of maturity groups 2xbw and 10xbw differ by 1.37 s and the meat:bone ratios by 4.14 s. Proportions of some muscles are given in Table 8 and in Figures 3 and 4. The influence of maturity is seen in the progressively lower proportion in the higher weight group of extensor and flexor muscles while the more proximally situated semitendinosus muscle increases in proportion. Consideration of the influence of the feeding level enforces the conclusion. The two dairy breeds have proportionately more of the distal muscles and of the neck muscle (longus colli) but less of the semitendinosus muscle and of the longissimus dorsi muscle. It appears noteworthy that the Pinzgauer (which in terms of meat:bone ratio, and also in terms of percentage of hindquarter, are below the other dual-purpose breeds) lead the other breeds by a rather wide margin in the relative proportion of longissimus dorsi muscle.

DISCUSSION

The major contrast in the breeds investigated is between the dual-purpose group FV, BV, and GV and the dairy breeds Sb and J; while Pi occupy a somewhat separate position. As to the influence of maturity the results conform with the expectation. In veal calves there is more bone and less fat than in the bulls and in both experiments the younger animals have a larger proportion of distal muscles.

Part of the breed differences are amenable to an interpretation in terms of different degrees of maturity. Therefore, we could attribute the higher proportion of shin muscles and lower proportion of the more proximal muscles in the dairy breed to a delayed maturity but the higher proportion of meat in the shoulder region points to earlier maturity as does the increased carcass fat content. Possibly these concepts of maturity gradient should be replaced by a rather different concept – these dairy breeds have comparatively early sexual maturity which is related to the large deposition of fat and the early increase in muscles of the shoulder-neck region. The relatively large proportion of hindquarter and knuckle in Friesian veal calves compared with a low proportion of these cuts in Friesian bulls points in the same direction. The other breed difference concerns the relatively high priority of

Table 7: Analysis of variance of muscle percentage of total meat

Muscle	Breed (R)	Feeding level	Maturity (Fu) level (Rei)	RxFu	RxRei	FuxRei	Residual
df	3	1	3	3	9	3	65
			F-Values				MQ
extensor carpi ulnaris	3.6		6.1				.0031
extensor digit. comm.	5.3	7.2	17.5	2.8			.0028
extensor digit. qu. prop.	3.3		11.4				.0014
extensor carpi radialis	12.1	3.8	13.8				.0032
extensor digit. tert. prop.		4.0	5.9				.0018
abductor pollic. long.	3.5	4.2	3.9	2.2			.0006
extensor group		3.9	17.2				.0087
flexor digit. superf.	4.1	3.0	10.8				.0025
splenius			40.4				.0172
longus colli	6.1						.0550
supraspinatus	4.8			2.6			.0204
infraspinatus	2.8						.0433
semitendinosus	19.8	3.9	7.7				.042
semimembranosus	10.5		29.8				.139
biceps femoris	8.8						.189
gracilis	8.9						.0095
psoas major			5.6				.0655
longissimus dorsi	5.7						.692

Only F values given if $F \geq 2$ at 3 df
Only F values given if $F \geq 3$ at 1 df

Table 8: Muscle (% x 1000 of total muscle) and tissue proportion (% of slaughter weight)

Muscle	*Breed*				*Rei*				*Fu*		$s_{\bar{x}}$	
	Fl	Pi	Sb	J	2x	4x	6x	10x	80	120	R.Rei	Fu
extensor carpi radial.	304	322	322	398	382	365	325	275	349	325	12	9
flexor digit. superf.	412	410	443	453	452	454	439	373	439	420	11	8
longus colli	860	944	949	1153							51	
semitendinosus	2657	2433	2260	2219	2264	2312	2501	2491	2348	2436	45	31
longissimus dorsi	6683	7125	6109	6244							180	127
bone %	19.46	20.77	21.63	24.00	23.99	22.55	21.24	18.07	21.89	21.04	32	22
fat %	5.21	5.59	5.11	4.79	3.8	4.73	5.31	6.86	4.82	5.53	31	22

Rei = multiples of birthweight, maturity level; Fu = feeding level; F1 = Fleckvieh; Pi = Pinzgauer; Sb = Friesian; J = Jersey; $s_{\bar{x}}$ = error of mean.

the skeletal system in dairy breeds which probably has to do with the importance of calcium metabolism for milk.

As mentioned before the Pinzgauer stand somewhat apart. In terms of tissue proportions they are between the other dual-purpose breeds and the dairy types. However, the muscle distribution shows a rathèr different pattern. The most conspicuous exception is the longissmus dorsi muscle which comprises a much larger share of the total muscle mass than in other breeds. Obviously this is because of the comparatively longer body of the Pinzgauer cattle.

As mentioned before, breed differences in muscle distribution are much less conspicuous than differences in tissue proportions. However, it appears that they are more important than Berg and Butterfield (1976) imply or Jones and colleagues (1978, 1980) and Berg and co-workers (1978) report. Most of these investigators used much more uniform material in terms of breeds than we used – Berg and Butterfield and Jones and colleagues report on British beef breeds and Friesians while the Danish material of Berg and colleagues involved crossbreds between Danish dairy breeds and Continental beef breeds. In contrast we compared Central European dual-purpose breeds with Jersey and high-grade Holsteins (Sb) and also had a representative of a rather different type (Pinzgauer). Therefore, we sampled probably a wider spectrum of types. Taylor and colleagues (1978) compared rather different types of sheep (for example, Southdown with Soay sheep), and they, too, found breed differences in muscle distributions to be more important than Berg and Butterfield's thesis led them to expect. Nevertheless, differences in muscle distribution between breeds appear to be quantitatively much less important than differences in tissue proportions. Therefore, the possibilities of changing muscle distribution by selection do not appear promising. In contrast, the various types of cattle have very different tissue proportions and genetic variation for them exists and is amenable to improvement.

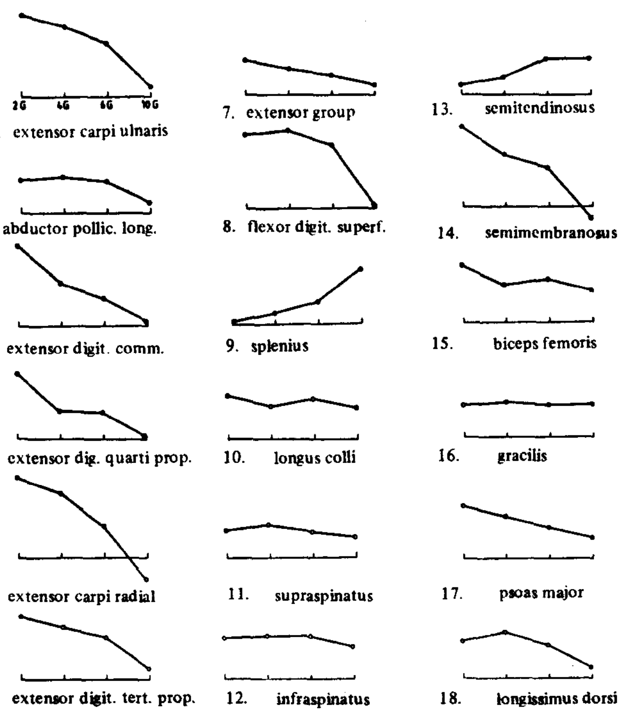


Figure 3: Muscles as percentage of total muscle at four maturity levels: 2G=double birthweight; 4G=fourfold birthweight; 6G=sixfold birthweight; 10G=tenfold birthweight.

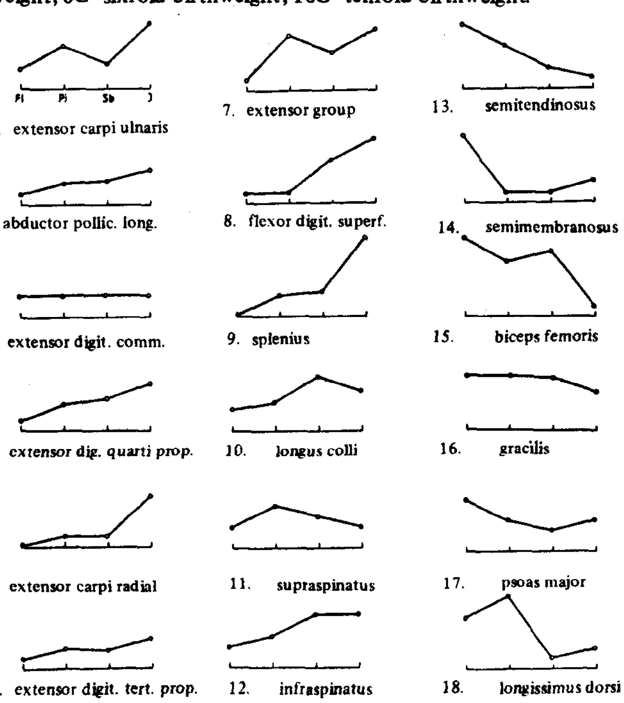


Figure 4: Muscles as percentage of total muscle weight of four breeds: FL = Fleckvieh; Pi = Pinzgauer; Sb = Friesian; J = Jersey.

SUMMARY

The composition of cattle carcasses has been studied both in terms of proportions of major tissues and in terms of commercial cuts relative to muscles. The investigations were carried out on some eighty-three twin animals from five breeds in one experiment and on ninety-six animals from four breeds in another experiment. Half the twin animals were slaughtered as veal calves, half as yearling bulls, while the ninety-six animals of Experiment 2 were grown at two levels of feeding and were slaughtered at the 2, 4, 6, or 10 x multiple of the breed-specific birthweight.

Increasing age and/or weight and higher feeding intensity caused the carcass proportion of meat and fat to increase and the relative weight of bone to decrease. Breed differences in proportions of major tissues are very important where dairy breeds have in general more carcass fat and a lower meat:bone ratio.

Commercial cuts and percentage of individual muscles also change with age and/or weight and with feeding intensity. However, these and the breed differences relative to muscle distribution, are less in magnitude than differences in tissue proportion. The animals from dairy breeds have more meat in distal muscles and in the shoulder-neck region; this may be caused by earlier sexual maturity of these breeds and by priority of the skeletal system of dairy types in nutrient distribution.

The breed differences are more important than in other similar studies. It is assumed that the breeds employed here represent a wider spectrum of diverse types than have been used in related studies.

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