

Collagen content of meat Carcasses of known history

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This study arose from the need for information on the collagen content of commercial cuts of beef and pork. Earlier studies at the Meat Research Institute have provided information on the collagen content of individual muscles (Nute, *et al*, 1984; Dransfield, *et al*, 1984). These values, however, were obtained from trimmed muscles and were, therefore not representative of commercial cuts of beef or pork. This study provides collagen values which are not presently available for a range of meat cuts commonly found in the UK.

Materials and methods

Thirteen beef carcasses were selected by the UK Meat and Livestock Commission (MLC) from four breeds to include four different levels of subcutaneous fat cover (MLC, November 1975). The breeds were Hereford, Friesian, Charolais, Aberdeen Angus. These were dissected into the following joints: Forequarter:- shin, brisket, Jacob's ladder, clod, sticking, fore-rib, chuck; hindquarter:- top-piece (Kempster, *et al*, 1980). Each joint was separated into three components, lean meat, subcutaneous fat and intermuscular fat which were weighed separately and samples of each tissue retained. All dissection was carried out by the MLC.

To prepare samples for analysis, portions of each of the three tissues were weighed individually according to the percentages of each present in the joints, as previously established by dissection. The three tissues were then combined into a composite sample representing each joint, which was then analysed for fat, moisture and collagen. In addition, representative samples of the total forequarter lean and fat were mixed together in the ratio established by physical separation of the whole quarter, this procedure was repeated for the hindquarter. Sub-samples of this recombined mixture from each quarter were analysed for fat, moisture and collagen.

Twenty-seven pig carcasses were selected from three commercial weight groups, pork, bacon and heavy hog, and animals of three levels of fatness, lean, average and fat, were included at each weight group (MLC, December 1973). One side from each of the carcasses was separated into lean, subcutaneous fat and intermuscular fat for purposes of carcass evaluation. The lean and fat were recombined and a representative sample of the mixture analysed for fat, moisture and collagen. Detailed analysis was carried out on individual joints from six of the pigs selected to represent the three weight groups and the two extremes of fat level (lean and fat). The joints were:- hand, collar, rump back and rib back, rump streak and rib streak, and ham (MLC, April 1975). Representative samples of each joint were prepared by the same procedure as described for the beef joints. Samples were analysed for fat, moisture and collagen, and did not include vertebral bone, or other bone and waste.

Sampling and analysis

The large amounts and the uneven distribution of connective tissue in some of the joints caused difficulties in the recombination of the separated tissues into an adequately homogeneous mince by mechanical mincing. Accordingly a portion of each tissue was finely chopped by hand and weighed separately before recombination into a single sample for analysis. Sub-samples were freeze-dried and defatted with diethyl ether (Soxhlet) and finally dried under vacuum at 70°C. Hydroxyproline was determined on the dry, fat-free sample by the ISO method (ISO 3496:1978); in this way collagen was estimated in samples of known fat and moisture content using the relationship: Collagen = hydroxyproline x 7.14 (Etherington, *et al*, 1981).

Results and discussion

The data were analysed using analysis of variance, and the least significant difference at the 5% level (L.S.D.) was used to compare means of significant factors; significant differences are indicated by differing superscripts.

Table 1 shows that the percentage collagen in the beef carcasses was significantly higher in meat from the forequarter than in that from the hindquarter. There were no breed differences. Analysis of the ten beef joints showed that within the forequarter the percentage collagen in the shin was, as expected, significantly higher than in the other six joints (Table 2). The complete ranking of joints, in decreasing order of percentage collagen was: shin > brisket, clod > sticking > Jacob's ladder, fore-rib, chuck. Within the hindquarter, the percentage collagen was significantly highest in the leg and significantly higher in the thin flank than in the other joints (Table 3). There were no significant breed differences within the forequarter or the hindquarter. The Aberdeen Angus was not compared owing to insufficient numbers of animals being available for examination. Free of external fat and gross aggregates of connective tissue, including the muscle sheath, show that collagen values for trimmed muscle, when expressed as a percentage of fresh tissue range from 0.5% in high quality meat such as shin to 3.5% in poorer quality meat such as shin and foreleg (Bendall, 1967; Dransfield *et al*, 1983; Prost *et al*, 1975).

Collagen values given by Porteous (1981) for commercial cuts of beef and pork are similar to those obtained in the present study which ranged from 1.2% in fat-free basis to 5.4% in shin with mean values from 1.9% (2.3% on a wet value for the total forequarter recombined sample was 2.5% (3.1% wff) and for the hindquarter recombined sample was 2.2% (2.7% wff). The overall mean value for collagen in beef was 2.3% (2.9% wff).

Results for pig carcasses showed (Table 4) that percentage collagen was significantly highest in the hand. The complete ranking of joints in decreasing order of percentage collagen was: hand > collar, streak > back, rib. The overall mean value for collagen in pigs was 1.6% (2.2% wff). When comparing joints used for manufacturing purposes with those used for retail, it has been pointed out (Brown, A J (MRI) private communication) that beef joints used for manufacturing may be grouped conveniently into: a) thin flank, and b) the forequarter joints excluding fore-rib. The thin flank

contains 3.0% collagen (wff), while the forequarter joints contain from 4.8% (wff) in shin to 2.4% (wff) in chuck and Jacob's ladder with a mean value of 3.1% (wff). The hindquarter joints, largely used for retail purposes, contain considerably less collagen with the exception of the leg which contains 4.2% (wff); the mean value for "other joints" is 2.3% (wff). With respect to pigs, the distinction between manufacturing and retail joints is less clear: any of the joints may be commonly used for either purpose.

The full paper describing this work will be published shortly in Meat Science.

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Table 1. Beef Carcasses: Means and Least Significant Differences of Percentage Collagen (wff) in Recombined Forequarter and Hindquarter

	BREED			
	H	F	Ch	
FQ	3.02	3.12	3.27	3.13 ^b
HQ	2.62	2.86	2.55	2.71 ^a
	2.82	2.99	2.91	

L.S.D. (FQ and HQ) = 0.163
L.S.D. (Breeds) = 0.515

Significant differences are indicated by differing superscripts.

Number of carcasses: Hereford (H) = 3
Friesian (F) = 5
Charolais (Ch) = 3

Table 2. Beef Carcasses: Means and Least Significant Differences of Percentage Collagen (wff) in Forequarter Joints

Joint	BREED			
	H	F	Ch	
Shin	4.75	4.97	4.40	4.76 ^d
Brisket	2.97	3.65	3.28	3.37 ^c
Jacob's Ladder	2.61	2.47	2.22	2.44 ^a
Clod	3.68	3.48	3.17	3.45 ^c
Sticking	3.08	3.07	2.92	3.03 ^b
Fore-rib	2.69	2.50	2.56	2.57 ^a
Chuck	2.41	2.44	2.23	2.37 ^a
	3.17	3.23	2.97	

L.S.D. (Joints) = 0.310
L.S.D. (Breeds) = 0.538

Table 3. Beef Carcasses: Means and Least Significant Differences of Percentage Collagen (wff) in Hindquarter Joints

	BREED			
	H	F	Ch	
Joint				
Leg	3.63	4.49	4.16	4.17 ^C
Thin Flank	2.73	3.42	2.43	2.96 ^b
Other Joints	2.43	2.41	2.11	2.34 ^a
	2.93	3.44	2.90	

L.S.D. (Joints) = 0.279
L.S.D. (Breeds) = 0.874

Table 4. Pig Carcasses: Means and Least Significant Differences of Percentage Collagen (wff) in Joints

	GROUP						
	HF	HL	BF	BL	PF	PL	
Joint							
Hand	3.09	2.54	3.61	2.79	2.63	2.60	2.87 ^C
Collar	3.08	2.15	2.13	2.60	2.59	2.06	2.43 ^b
Back	2.56	1.99	2.49	2.17	1.69	1.72	2.10 ^a
Streak	3.24	2.35	3.47	2.08	2.08	2.23	2.57 ^b
Ham	1.94	1.51	1.69	1.75	2.58	1.43	1.81 ^a
	2.78 ^b	2.11 ^a	2.68 ^b	2.28 ^a	2.31 ^a	2.01 ^a	

L.S.D. (Joints) = 0.293
L.S.D. (Groups) = 0.320

Results are for six pig carcasses
H = Heavy F = Fat
B = Bacon L = Lean
P = Pork