

The Composition of Fresh Pork

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Recent analytical results for the major constituents of certain cuts of fresh raw pork as used for the production of Wiltshire bacon are presented. The paper highlights the limitations in the use of a single nitrogen factor for the estimation of lean meat in evaluating the curing solution content of bacon.

Scientific literature contains an abundance of references to the composition of fresh pork. A survey of results was included in a 1971 publication from the British Food Manufacturing Industries Research Association¹. Studies of the literature show that the composition of pork carcass flesh is variable according to a number of factors, including the anatomical location of the cut, the age and weight of the pig at slaughter, the sex and feeding regime of the animal^{2,3,4}.

The natural composition of pork, and in particular the nitrogen or protein content, is used as a basis for estimating the lean raw pork content of meat products and for most practical purposes the natural variability of the pork has been overcome by analysts using agreed common average figures or factors. The use of a single average factor for nitrogen content of pork is valid when the meat product is comminuted and utilises pork from several different anatomical locations and different pigs. A nitrogen factor of 3.6 (meaning 3.6 per cent nitrogen in fat-free pork) was used for enforcement purposes from 1940–1961⁵, and from 1961 the generally agreed factor² has been 3.45. However, analyses at this laboratory of bacon and ham products cured from specific cuts of pork indicated that the use of a single nitrogen factor was unsatisfactory for estimating the lean meat content and hence curing solution content of these products.

In order to resolve this problem, a project was undertaken in 1980–1981 to obtain new analytical data on pork sampled at specific anatomical locations from freshly slaughtered pigs of the quality and weight used for Wiltshire bacon production.

Experimental

MATERIALS

All pig carcasses sampled came from gilt or castrated bacon pigs of the top AA1 grade, in the range 59–72 kg cold deadweight, minimum length 775 mm (first rib to aitch bone), P2 probe maximum 16 mm (fat depth at last rib, 6.5 cm from centre-line), shoulder and loin fat maximum thicknesses of 42 mm and 22 mm, respectively.

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The slaughtering, dressing and chilling were in accordance with the BMMA Code of Practice⁶. This standard procedure includes scalding the carcass in water, singeing and scraping, then washing the dressed carcass lightly to remove bone dust debris. Carcass chilling to an internal muscle temperature of 4°C takes up to 16 h. Some of these procedures may slightly affect the surface composition of the flesh, for example carcasses typically lose 1.5–2 per cent by weight between hot and cold weights, and the expression "fresh pork" is here understood to mean pork as produced according to these standard procedures and sampled the morning after slaughter.

Transverse sections were taken from chilled carcasses at the four locations indicated in Figure 1, namely hind-leg, mid-back, mid-belly and fore-end, such that each section weighed at least 1 kg. Samples were wrapped in polythene bags and immediately transported in a chilled box to the laboratory for analysis. During the project, samples were taken from a total of eleven different factories in England.

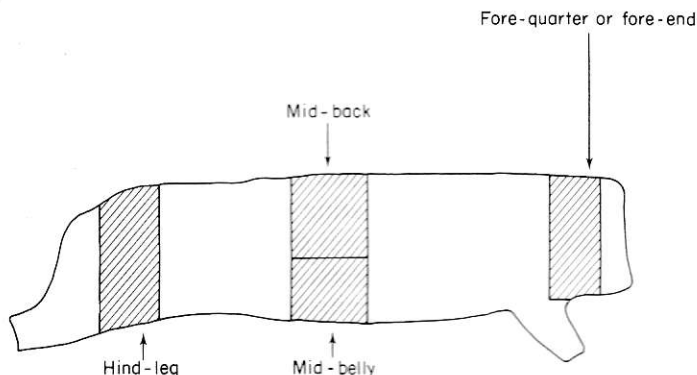


Fig. 1. Pork carcass showing the four sections sampled for this study.

At the laboratory, samples were prepared rapidly and analysed with minimum delay. Each sample was carefully divided into lean, fatty tissue, rind and bone/cartilage and each component weighed. Although care was given to separating the major part of visible fatty tissue from both lean and rind (not more than 2 mm depth of fat left on rind) and allocating all fragments to their correct fractions, the main emphasis was on speed in order to minimise losses of moisture. Any drip liquor present in the sample bag was weighed, analysed separately and the results ultimately added back to the lean tissue. After weighing, the bone/cartilage was discarded. The three remaining components (sub-samples) of each sample were separately minced through a plate having holes of diameter 4mm, and were then kept at 5°C in closed wide-mouthed glass jars. Care was taken before removing aliquots to remix the prepared sub-sample where any separation of moisture had occurred.

In all, 40 such samples were selected for analysis representing 10 hind-legs, 10 backs, 10 bellies and 10 fore-ends. Each sample consisted of the three sub-samples which were analysed separately. No two samples from the same position on the carcass came from any one factory.

Methods

Each sub-sample was analysed for total nitrogen (protein = $N \times 6.25$), total fat, moisture and ash by methods as described by the SAC⁷. Replicate analyses were carried out until the sum of the protein, fat, moisture and ash for each sub-sample was within 99–101 per cent for lean and fatty tissue or 98–102 per cent for rind.

Results and Discussion

The results are presented in Tables I–VII and relate to the boneless pork. Nitrogen, moisture and ash contents are calculated on a fat-free basis. The “Apparent total meat content” in the last column of Tables II–VII is calculated using the present common nitrogen factor of 3.45. Tables II–VI are arranged by anatomical location and in addition to results for lean tissue, fatty tissue and rind, each Table includes results for (1) lean and fatty tissues and (2) lean, fatty and rind tissues (combined in natural proportions in each case), calculated from the individual sub-samples of each sample.

A study of the results indicates the following.

(a) That for most named sub-samples from a particular anatomical location, the standard deviation for the nitrogen content, on a fat-free basis, is less than the standard deviation for the water-to-protein ratio. Thus the nitrogen content appears to be more reliable than the water-to-protein ratio as a basis for calculating lean meat and hence added water content.

(b) That the use of a single 3.45 nitrogen factor for calculating apparent lean and hence total meat content significantly overestimates the lean in back, belly and middle-cut pork and underestimates the lean in pork from the fore. How-

TABLE I
PROPORTIONS OF LEAN, FATTY AND RIND TISSUES IN FRESH PORK
(BY WEIGHT; BONELESS)

	Lean tissue %	Fatty tissue %	Rind %
<i>Hind leg</i> ($n = 10$) (rind-on)			
Mean	84.0	11.2	4.8
Standard deviation	1.8	2.2	0.9
Range	80.4–86.1	8.9–15.5	3.9–6.5
<i>Back</i> ($n = 10$) (rind-on)			
Mean	66.2	25.3	8.5
Standard deviation	3.2	3.5	1.9
Range	60.9–71.5	18.5–30.9	5.8–11.5
<i>Belly</i> ($n = 10$) (rind-on)			
Mean	70.0	17.7	12.3
Standard deviation	6.3	6.5	4.0
Range	59.9–78.0	10.2–30.9	7.7–19.2
<i>Middle-cut</i> ($n = 10$), (rind-on, combined back and belly)			
Mean	67.8	22.2	10.0
Standard deviation	3.6	4.2	2.3
Range	62.4–74.2	15.1–30.9	6.7–13.9
<i>Fore</i> ($n = 10$) (rind-on)			
Mean	79.2	15.1	5.7
Standard deviation	4.8	3.6	1.6
Range	70.1–83.5	10.4–21.5	3.4–8.4

TABLE II
COMPOSITION OF HIND LEG PORK (BY WEIGHT; BONELESS)

	Fat %	Calculated on fat-free basis			Water: protein ratio	Apparent total meat content (lean* + fat) %
		Moisture %	Ash %	Nitrogen %		
<i>Lean tissue (n = 10)</i>						
Mean	3.8	77.2	1.16	3.47	3.57	100.5
Standard deviation	1.6	0.8	0.05	0.08	0.11	2.4
Range	2.3-8.0	76.1-79.1	1.10-1.25	3.39-3.61	3.39-3.68	98.4-104.5
<i>Fatty tissue (n = 10)</i>						
Mean	74.9	75.9	1.25	3.72	3.31	101.8
Standard deviation	3.9	4.3	0.24	0.39	0.49	2.8
Range	70.1-82.1	70.1-83.9	0.84-1.64	3.13-4.28	2.61-4.18	97.4-105.7
<i>Rind (n = 10)</i>						
Mean	28.3	60.9	0.81	6.09	1.62	155.0
Standard deviation	6.3	4.1	0.09	0.57	0.25	14.0
Range	20.3-38.0	53.9-65.7	0.61-0.92	5.33-7.10	1.22-1.96	137.7-182.9
<i>Lean and fatty tissues combined (n = 10)</i>						
Mean	12.1	77.2	1.16	3.48	3.56	100.7
Standard deviation	3.1	0.9	0.04	0.08	0.11	2.1
Range	9.1-20.0	76.1-79.1	1.10-1.24	3.39-3.62	3.37-3.69	98.4-104.4
<i>Lean, fatty and rind tissues combined (n = 10)</i>						
Mean	12.9	76.6	1.15	3.58	3.42	103.3
Standard deviation	2.8	0.8	0.04	0.08	0.08	1.9
Range	10.4-20.1	75.6-78.1	1.09-1.21	3.49-3.72	3.28-3.54	101.1-106.7

* Apparent lean content calculated from a 3.45 nitrogen factor.

TABLE III
COMPOSITION OF BACK PORK (BY WEIGHT; BONELESS)

	Fat %	Calculated on fat-free basis			Water: protein ratio	Apparent total meat content (lean* + fat) %
		Moisture %	Ash %	Nitrogen %		
<i>Lean tissue (n = 10)</i>						
Mean	9.9	76.4	1.17	3.64	3.36	104.9
Standard deviation	2.3	1.1	0.04	0.06	0.09	1.7
Range	6.1-14.9	74.9-77.8	1.12-1.26	3.53-3.73	3.21-3.48	102.0-107.3
<i>Fatty tissue (n = 10)</i>						
Mean	82.0	71.8	1.16	4.20	2.77	103.8
Standard deviation	3.9	5.8	0.37	0.50	0.40	2.9
Range	72.7-86.3	61.5-79.7	0.81-2.06	3.30-4.92	2.11-3.60	98.8-107.8
<i>Rind (n = 10)</i>						
Mean	19.6	61.4	0.71	6.12	1.61	162.8
Standard deviation	8.3	2.8	0.10	0.36	0.16	13.7
Range	8.8-34.1	57.1-65.6	0.58-0.90	5.50-6.61	1.39-1.91	146.5-183.6
<i>Lean and fatty tissues combined (n = 10)</i>						
Mean	29.8	76.1	1.17	3.68	3.31	104.6
Standard deviation	4.7	1.0	0.06	0.09	0.10	1.7
Range	19.8-37.5	75.0-77.9	1.10-1.30	3.50-3.83	3.14-3.49	101.2-107.2
<i>Lean, fatty and rind tissues combined (n = 10)</i>						
Mean	29.1	74.7	1.13	3.91	3.06	109.5
Standard deviation	4.5	1.0	0.06	0.07	0.08	1.3
Range	19.4-36.3	73.7-76.4	1.04-1.25	3.80-4.06	2.91-3.16	107.9-111.9

* Apparent lean content calculated from a 3.45 nitrogen factor.

TABLE IV
COMPOSITION OF BELLY PORK (BY WEIGHT; BONELESS)

	Fat %	Calculated on fat-free basis			Water: protein ratio	Apparent total meat content (lean* + fat) %
		Moisture %	Ash %	Nitrogen %		
<i>Lean tissue (n = 10)</i>						
Mean	19.3	78.3	1.18	3.50	3.59	101.2
Standard deviation	2.7	1.1	0.10	0.10	0.14	2.4
Range	16.0-24.1	76.4-79.8	1.09-1.40	3.36-3.65	3.39-3.81	97.7-104.6
<i>Fatty tissue (n = 10)</i>						
Mean	76.2	73.8	1.27	3.99	2.98	103.6
Standard deviation	5.1	4.3	0.24	0.34	0.39	2.4
Range	68.9-82.4	68.1-81.0	0.87-1.70	3.47-4.62	2.48-3.76	100.2-107.5
<i>Rind (n = 10)</i>						
Mean	27.8	64.7	0.79	5.55	1.89	144.0
Standard deviation	11.8	3.9	0.09	0.50	0.27	13.1
Range	15.4-50.3	59.4-71.0	0.64-0.89	4.85-6.25	1.55-2.23	124.5-168.5
<i>Lean and fatty tissues combined (n = 10)</i>						
Mean	30.8	78.0	1.19	3.53	3.54	101.6
Standard deviation	5.8	1.1	0.09	0.10	0.13	2.0
Range	22.6-41.0	76.1-79.7	1.09-1.37	3.39-3.69	3.33-3.76	98.5-104.5
<i>Lean, fatty and rind tissues combined (n = 10)</i>						
Mean	30.7	76.3	1.14	3.78	3.22	106.6
Standard deviation	5.6	1.3	0.08	0.10	0.13	1.9
Range	22.7-39.1	74.0-77.5	1.05-1.27	3.67-3.99	2.96-3.36	104.3-110.8

* Apparent lean content calculated from a 3.45 nitrogen factor.

TABLE V
COMPOSITION OF MIDDLE-CUT PORK
(COMBINED BACK AND BELLY PORK; BONELESS; BY WEIGHT)

	Fat %	Calculated on fat-free basis			Water: protein ratio	Apparent total meat content (lean* + fat) %
		Moisture %	Ash %	Nitrogen %		
<i>Lean and fatty tissues combined (n = 10)</i>						
Mean	30.2	76.8	1.18	3.62	3.40	103.3
Standard deviation	4.8	1.0	0.06	0.08	0.11	1.6
Range	20.9-37.9	75.6-78.5	1.11-1.32	3.45-3.72	3.26-3.60	100.0-105.2
<i>Lean, fatty and rind tissues combined (n = 10)</i>						
Mean	29.8	75.4	1.14	3.86	3.13	108.3
Standard deviation	4.6	0.9	0.06	0.07	0.09	1.4
Range	20.8-37.6	73.9-76.7	1.06-1.26	3.76-3.96	2.99-3.24	106.3-110.9

* Apparent lean content calculated from a 3.45 nitrogen factor.

TABLE VI
COMPOSITION OF FORE END PORK (BY WEIGHT; BONELESS)

	Calculated on fat-free basis				Water: protein ratio	Apparent total meat content (lean* + fat) %
	Fat %	Moisture %	Ash %	Nitrogen %		
<i>Lean tissue (n = 10)</i>						
Mean	10.5	78.6	1.14	3.21	3.92	93.7
Standard deviation	2.0	0.8	0.05	0.10	0.14	2.7
Range	6.5-13.9	77.5-79.9	1.05-1.22	3.04-3.33	3.74-4.15	88.8-97.0
<i>Fatty tissue (n = 10)</i>						
Mean	77.6	70.9	1.04	4.10	2.81	104.2
Standard deviation	2.9	3.4	0.16	0.44	0.34	2.7
Range	73.2-82.1	64.8-78.1	0.84-1.38	3.19-4.92	2.36-3.58	98.3-108.2
<i>Rind (n = 10)</i>						
Mean	35.1	61.2	0.81	6.17	1.63	150.5
Standard deviation	8.3	4.9	0.07	0.85	0.35	15.8
Range	23.0-49.4	53.6-66.8	0.67-0.93	5.14-7.43	1.16-2.03	131.2-179.7
<i>Lean and fatty tissues combined (n = 10)</i>						
Mean	21.2	78.2	1.13	3.25	3.86	95.3
Standard deviation	3.0	0.8	0.05	0.08	0.12	2.0
Range	17.6-27.0	77.1-79.5	1.04-1.21	3.11-3.36	3.72-4.05	92.2-97.8
<i>Lean, fatty and rind tissues combined (n = 10)</i>						
Mean	22.1	77.5	1.12	3.38	3.68	98.4
Standard deviation	3.2	0.8	0.05	0.08	0.11	1.8
Range	17.9-28.2	76.5-78.9	1.04-1.19	3.27-3.52	3.55-3.82	95.9-101.6

* Apparent lean content calculated from a 3.45 nitrogen factor.

TABLE VII
COMPOSITION OF PORK RIND (BY WEIGHT)

	Calculated on fat-free basis				Water: protein ratio	Apparent total meat content (lean* + fat) %
	Fat %	Moisture %	Ash %	Nitrogen %		
<i>Rind (n = 30)†</i>						
Mean	29.1	61.7	0.79	6.04	1.66	152.9
Standard deviation	9.0	4.1	0.08	0.63	0.26	13.7
Range	12.5-49.4	53.6-67.1	0.60-0.93	5.14-7.43	1.16-2.03	131.2-182.9

* Apparent lean content calculated from a 3.45 nitrogen factor.

† These rinds are the sub-samples from the hind legs (10), fores (10), and the combined rinds (10) of the backs and bellies.

ever, Table VIII confirms that a 3.45 nitrogen factor is valid for comminuted pork products incorporating meat from several different cuts and pigs.

(c) That more specific nitrogen factors should be used for calculating lean meat contents in those cases where meat from an identifiable cut is used for a meat product.

Following these findings, revised nitrogen factors were employed in this laboratory for calculating the lean meat and thence curing solution contents of

TABLE VIII
NITROGEN FACTORS FOR FRESH PORK

A nitrogen factor as used for calculation of lean meat content is the mean nitrogen content on a fat-free basis of the appropriate cut(s) of meat.

All but the last item are abstracted direct from Tables II-VI. The nitrogen factors for whole boneless pork carcass are calculated from the other items on the basis that an average boneless side of a bacon pig carcass consists of 28 parts hind leg, 24 parts back, 19 parts belly and 29 parts fore end by weight.

	Mean nitrogen content % (on fat-free basis)
Hind leg pork	
<i>Lean tissue</i>	3.47
<i>Lean and fatty tissues combined</i>	3.48
<i>Lean, fatty and rind tissues combined</i>	3.58
Back pork	
<i>Lean tissue</i>	3.64
<i>Lean and fatty tissues combined</i>	3.68
<i>Lean, fatty and rind tissues combined</i>	3.91
Belly pork	
<i>Lean tissue</i>	3.50
<i>Lean and fatty tissues combined</i>	3.53
<i>Lean, fatty and rind tissues combined</i>	3.78
Fore end pork	
<i>Lean tissue</i>	3.21
<i>Lean and fatty tissues combined</i>	3.25
<i>Lean, fatty and rind tissues combined</i>	3.38
Whole boneless pork carcass	
<i>Lean tissue</i>	3.44
<i>Lean and fatty tissues combined</i>	3.47
<i>Lean, fatty and rind tissues combined</i>	3.64

bacon and ham samples (not containing added proteinaceous matter). The nitrogen factors were selected from Tables II-VI according to the nearest appropriate anatomical location of each sample and due regard was taken to the presence or absence of rind. It was found that the use of these revised factors much improved the correlation between the curing solution contents of samples estimated by analysis and the figures expected from weight measurements taken in the curing factory. However, the ability to use other selected nitrogen factors does assume that the analyst is aware of the approximate anatomical source of each sample.

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