The Association of Public Analysts

Guidance on the Estimation of the Meat Content of Meat and Meat Products Containing Beef, Pork or Sheep Meat

6th Draft
January 2001
1. **Introduction**

1.1 The estimation of the meat content of meat and meat products is necessary to enable the enforcement of legislation relating to these products.

1.2 The quantitative estimation of meat is currently based on the measurement of the nitrogen from the meat and its relationship to the levels found naturally in different types of meat.

1.3 Meat is a natural product and its composition is subject to variation which is recognised in the derivation of data for enforcement purposes, the burden of proof is to demonstrate beyond reasonable doubt.

1.4 The method of Stubbs and More has been used since 1919 to estimate the apparent meat content of meat and meat products and remains the basis of the Association’s approach.

1.5 Collagen is a natural constituent of muscle and other meat tissues and contributes to the meat nitrogen content. Regulations require that collagenous tissue is only permitted to count towards the meat content up to the amount naturally associated with the flesh used. There has been much debate over the amount of collagen that is naturally associated with meat ingredients used in meat products.

1.6 The Analytical Methods Committee (AMC) of the Royal Society of Chemistry have published data on the composition of meat for most commonly encountered species, these data form the basis of the Association's choice of factors used in meat content calculations.

1.7 When it is known which cut(s) of meat are present in a particular product the appropriate factors for the cut(s) can be used in the calculations set out later in this document. When the exact nature of the meat ingredients used is uncertain much information can be gleaned from the labelling of the product. The name and supplementary description of the food, the list of ingredients, claims etc are likely to provide some information on the meat ingredient(s). For example terms such as 'high quality', 'premium', 'selected' in relation to meat will normally indicate cuts of superior quality in terms of higher muscle and lower fatty and connective tissues.

2. **Methods of Analysis**

2.1 Analysis for enforcement purposes must be carried out using validated accredited methods which are subject to appropriate ongoing AQC checks within an AQA system.
2.2 Soya may be determined using soya protein as the analyte; the protein is present at levels of over 90% in isolates and over 50% in flours. When correcting for the nitrogen content of soya in meat content calculations the carbohydrate content of the type of soya used must be taken into account. In soya flour for example the ratio of protein to carbohydrate is typically 2 to 1.5.

2.3 Non-meat nitrogen sources other than soya protein and cereal may be present (serum or bone protein for example) and although this may present analytical difficulties appropriate allowances must be made.

3. **Nitrogen Factors**

3.1 The nitrogen content of meat varies with the species, age, part of the carcass, sex, breed, season and many other factors. For enforcement work it is essential to obtain as much information as possible about the nature of the meat ingredients of meat products. This enables an informed judgement to be made on the choice of the most appropriate nitrogen factor from published AMC data or other sources.

3.2 If there is no information about the meat ingredients the Association recommends the use of a nitrogen factor which represents meat from all parts of the carcass of the species used.

3.3 Many AMC studies include statistical data relating to the parameters measured. The Association recommends that when writing reports and certificates its members use average nitrogen factors based on the published data. When advising if enforcement action is appropriate, the reliability of the reported value will be an important consideration.

3.4 If products are analysed which are likely to contain only the meat from an individual animal, consideration should be given to using factors which recognise the greater likelihood of extreme values. In the vast majority of meat products analysed in today’s market however the meat content will have resulted from the homogenisation of the meat from many animals and mean values for factors will be appropriate.

3.5 The mean nitrogen factors from the AMC studies are given in table 1.

3.6 For beef, pork, lamb and mutton mean AMC nitrogen factors for particular parts of the carcass are shown graphically in figures 1 to 3. The graphs include the estimated confidence interval for the mean (±3 x standard error).

3.7 A nitrogen factor which is most appropriate to the meat ingredients of the sample under consideration should be selected from table 1, figures 1 to 3 or, in cases where no AMC data is available, from the literature, reference works (e.g. McCance and Widdowson) or data produced in-house.
Table 1

AMC Recommended Mean Nitrogen Factors and Other Related Data

<table>
<thead>
<tr>
<th></th>
<th>Mean Nff</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef</td>
<td>3.65</td>
<td>Analyst, 1993, 118, 1217</td>
</tr>
<tr>
<td>Pork</td>
<td>3.50</td>
<td>Analyst, 1991, 116, 761</td>
</tr>
<tr>
<td></td>
<td>3.50</td>
<td>Analyst, 1987, 112, 1169</td>
</tr>
<tr>
<td>Sheep Meat</td>
<td>3.50</td>
<td>Analyst, 1995, 120, 1823</td>
</tr>
<tr>
<td>Lamb and Mutton</td>
<td>3.50</td>
<td>Analyst, 1996, 121, 889</td>
</tr>
<tr>
<td>Chicken</td>
<td>3.60</td>
<td>Analyst, 1963, 88, 583</td>
</tr>
<tr>
<td></td>
<td>3.90</td>
<td>Analyst, 1963, 88, 583</td>
</tr>
<tr>
<td>Turkey</td>
<td>3.50</td>
<td>Analyst, 1965, 90, 581</td>
</tr>
<tr>
<td></td>
<td>3.90</td>
<td>Analyst, 1965, 90, 581</td>
</tr>
<tr>
<td>Kidney</td>
<td>2.70</td>
<td>Analyst, 1966, 91,538</td>
</tr>
<tr>
<td>Tongue</td>
<td>3.00</td>
<td>Analyst, 1967, 92,326</td>
</tr>
<tr>
<td>Blood</td>
<td>3.20</td>
<td>Analyst, 1968, 93,478</td>
</tr>
<tr>
<td>Veal</td>
<td>3.35</td>
<td>Analyst, 1965, 90,256</td>
</tr>
<tr>
<td>Ox Liver</td>
<td>3.45</td>
<td>Analyst, 1964, 89,630</td>
</tr>
</tbody>
</table>

Some of the earlier figures recommended should be treated with caution as they change in time with the introduction of new breeds and with changes in composition of the animals with differing husbandry practices.
Variation of Fat-Free Nitrogen (Nff)

Figure 1
Variation of Fat-Free Nitrogen (Nff)

DATA RELATING TO CUTS OF PORK
Ranges: Based on 3 x std error (trial involved 38 sides of pork)

[Diagram showing variation of fat-free nitrogen for different cuts of pork]

Figure 2
Variation of Fat-Free Nitrogen (Nff)

DATA RELATING TO CUTS OF LAMB AND MUTTON


Ranges: Based on 3 x std error (trial involved 81 lambs, 45 sheep)

Figure 3
4. Calculation of Meat Content Allowing all Connective Tissue to Count as Meat - Calculation 1

4.1 The method of calculation of Stubbs and More is based on the determination of water, protein, fat and ash content of the sample. Carbohydrate (C) is normally determined by difference:

\[ C = 100 - (\% \text{ water} + \% \text{ fat} + \% \text{ protein} + \% \text{ ash}) \]

where \( \% \text{ protein} = 6.25 \times \% \text{ total nitrogen} \)

A factor of 6.25 is used to calculate the protein from the total nitrogen content even though the total protein may include proteins for which a different factor would be more appropriate (e.g., soya protein, casein or added gelatine). It should be noted that for simplicity the 6.25 factor is used throughout the meat calculation e.g. when calculating the amount of nitrogen contributed from non-meat protein.

4.2 When the sample contains carbohydrate the nature of the filler can be determined by microscopy and a suitable deduction for the nitrogen associated with the carbohydrate made from the total nitrogen. Average values for the nitrogen content of some common fillers are:

- wheat rusk = 2% of the dry carbohydrate
- potato starch = 0%

4.3 If the sample contains other non-meat nitrogenous sources (e.g., soya, casein) a deduction must also be made from the total nitrogen for their contribution to the total nitrogen.

\[ \text{Soya nitrogen} = \text{soya protein} \div 6.25 \]
\[ \text{Casein nitrogen} = \text{casein} \div 6.38 \]

4.4 The defatted meat content (DFM) is calculated as:

\[
\% \text{ DFM} = \frac{(N_t - N_c) \times 100}{N_{ff}}
\]

where \( N_t = \% \text{ total nitrogen} \)
\( N_c = \text{total non-meat nitrogen (4.3))} \)
\( N_{ff} = \text{fat free nitrogen content of the meat (see section 3)} \)

4.5 The Association accepts that lean meat may contain up to 10 percent of intramuscular lipid. The lean meat content is therefore the lesser of:

\[
\% \text{ Lean Meat (LM)} = \% \text{ DFM} \times \frac{100}{90}
\]
or, where the fat content is less than 10% of the lean meat content:

\[
\% \text{ Lean Meat (LM)} = \% \text{DFM} + \text{Total Fat}
\]

4.6 The calculation of the total meat content must take account of any prescribed minimum lean meat standard (and hence maximum fat standard) and not allow excessive levels of fat to count towards the total meat content. The total meat content is therefore the lesser of:

\[
\% \text{ Total Meat} = \text{LM} \times \frac{100}{\text{LM min}}
\]

at the upper fat limit or

\[
% \text{ Total Meat} = \% \text{DFM} + \% \text{Total Fat}
\]

where there is less than the maximum permitted level of fat present and where:

\[
\text{LM min} = \text{the required minimum lean meat content expressed as a } \% \text{ of the total meat content (i.e. 50 or 65)}
\]

4.7 Any fat over and above that allowed for by the prescribed minimum lean meat content as a proportion of total meat is discounted for the purpose of total meat content and must be separately declared in the list of ingredients. The calculation at 4.6 allows for any fat associated with lean meat over and above the minimum required lean meat content legitimately to count towards the total meat content.

\[
\text{Excess Fat} = \text{Total Fat} - (\text{Total Meat} - \text{Defatted Meat})
\]

4.8 The calculation at 4.1 to 4.5 includes all of the collagen, any added gelatine and any other non-meat nitrogenous matter present not otherwise allowed for to contribute to the total meat content.
5. Calculation of Meat Content Allowing Collagen only in Amounts Naturally Associated with the Flesh Used - Calculation 2

5.1 Collagen, the connective tissue protein has a uniquely high content of the amino acid hydroxyproline which provides a useful way of estimating the connective tissue content of meat and meat products. The Association recommends that a factor of 8 is used to convert hydroxyproline to collagen:

\[
\% \text{ collagen} = \% \text{ hydroxyproline} \times 8
\]

5.2 Collagen and connective tissue are expressed in a variety of ways. The Association recommends that when considering maximum acceptable collagen levels in meat ingredients the most appropriate measure is the collagen to total meat protein ratio (CPR). This concept is used in UK and EU law. The ratio varies from 0 for collagen-free meat to 1 for pure collagen.

\[
\text{Collagen : Protein Ratio (CPR)} = \frac{\% \text{ hydroxyproline} \times 8}{\% \text{ Total Meat Nitrogen} \times 6.25}
\]

where Total Meat Nitrogen includes collagen

5.3 Analytically determined collagen will include added gelatine. If the amount of added gelatine is known a correction can be made for the gelatine nitrogen:

\[
\% \text{ Gelatine Nitrogen} = \frac{\% \text{ added gelatine}}{6.25}
\]

If the amount of added gelatine is unknown and not taken into account the meat content will be overestimated. In the case of canned meat products with added gelatine the amount is typically 0.5% (as dry gelatine). It should be noted that a high proportion of the total gelatine present in the final product would have come from the meat itself following heat treatment.

5.4 The basic Stubbs and More calculation is modified to restrict the amount of collagen as follows:

5.4.1

\[
\% \text{ Collagen Free Meat Nitrogen (CFMN)} = \% N_t - \% N_c - \% N_{coll}
\]

where 
\[N_t = \text{Total Nitrogen}\]
\[N_c = \text{Total Non-Meat Nitrogen}\]
\[N_{coll} = \text{Collagen Nitrogen}\]

which becomes:
5.4.2 Total Meat Nitrogen (TMN) = \( \frac{CFMN}{1 - CPR} \)

where \( CPR = \) the mean collagen protein ratio of the meat used (see section 6) or the actual value in the meat ingredient if this is less than CPR. This allows collagen nitrogen to contribute to the meat nitrogen up to a limit of the amount of collagen naturally associated with the flesh used.

\[
CFMN = \frac{Nt - Nc - \frac{8 \times \text{Hydroxyproline (OHP)}}{6.25}}{1.28 - \frac{Nc}{Nt}} \]

5.4.3 \% Defatted Meat (DFM) = \( \frac{TMN \times 100}{Nff} \)

5.4.5 The above steps can be simplified to:

\[
\%DFM = \frac{Nt - Nc - (1.28 \times OHP)) \times 100}{(1 - CPR) \times Nff}
\]

In cases where all the collagen present counts towards the meat content (i.e. CPR = actual collagen protein ratio of the product) this reduces to the more familiar Stubbs and More calculation:

\[
\%DFM = \frac{(Nt - Nc) \times 100}{Nff}
\]

5.4.6 This calculation allows all the collagen present to count as defatted meat and therefore total meat up to a limit established by the magnitude of CPR.

5.4.7 The calculation of lean and total meat are exactly the same as in 4.4 and 4.5 respectively:

\[
\% \text{Lean Meat (LM)} = \frac{\% DFM \times 100}{90}
\]

or

\[
\% LM = \% DFM + \% \text{Total Fat}
\]

and
It is not appropriate to add back more collagen derived from the additional fat at this stage as all of the allowable collagen has been included in the defatted meat.

5.4.8 In cases where the amount of collagen present is greater than the amount naturally associated with the flesh used, the amount of ‘excess’ collagen as a percentage of the sample can be calculated from the following formula:

\[
\text{Excess Collagen} = \frac{\text{Total Collagen} - \text{CPR} (\text{Total Protein} - \text{Total Non} - \text{Meat Protein} - \text{Total Collagen})}{1 - \text{CPR}}
\]

\[
\text{Excess Collagen} = \frac{8 \times \text{OHP} - \text{CPR}(6.25 \times \text{Nt} - \text{Total Non} - \text{Meat Protein} - 8 \times \text{OHP})}{1 - \text{CPR}}
\]

where Excess Collagen is expressed as a percentage of the sample.
6. How Much Collagen is Naturally Associated with the Flesh Used?

6.1 The Association accepts that the law allows fat to count towards the meat content. The amount of fat is limited by the fact that meat products are required to have a lean meat content of at least 50 or 65 percent of the required (or actual) meat content of the food. The consequence of this is that the meat content of some meat products will quite legitimately contain amounts of fat in excess of that naturally associated with the flesh used, the ‘naturally associated’ reference in the definition of meat does not apply to fat. In such cases as fat contains significant amounts of collagen the collagen protein ratio of the meat content of meat products may exceed that of AMC cuts and cuts with which consumers are familiar.

6.2 In order to establish an appropriate maximum value for the collagen protein ratio the variation of this ratio with decreasing lean meat content, and hence increasing fat content, can be considered.

6.3 The meat content of meat products is made up of a combination of lean meat, skin (in the case of rind-on pork and poultry) and fatty tissue. The composition of many of these component parts of the meat content of meat products has been established by AMC studies. Using the AMC data it is a simple matter to calculate the contribution from each of these three components to the collagen, protein and the collagen protein ratio of the meat content of meat products consisting of various combinations of lean meat, fat and skin.

6.4 The terms used are:

\[
\begin{align*}
N_{fat} &= \% \text{ nitrogen in the fatty tissue} \\
N_{lean} &= \% \text{ nitrogen in the skinless / rindless lean meat} \\
N_{skin} &= \% \text{ nitrogen in the skin / rind} \\
C_{fat} &= \% \text{ collagen in the fatty tissue} \\
C_{lean} &= \% \text{ collagen in the skinless / rindless lean meat} \\
C_{skin} &= \% \text{ collagen in the skin / rind}
\end{align*}
\]

The assumptions made are:

\[
\begin{align*}
F &= \% \text{ fatty tissue in the meat content} \\
L &= \% \text{ lean in the meat content} \\
S &= \% \text{ skin / rind in the meat content} \\
F + L + S &= 100\% \text{ of the meat content of the product}
\end{align*}
\]

6.5 For products containing skin / rind:

\[
\text{Collagen : Protein Ratio (CPR)} = \frac{(F \times C_{fat}) + (L \times C_{lean}) + (S \times C_{skin})}{6.25 \times ((F \times N_{fat}) + (L \times N_{lean}) + (S \times N_{Skin}))}
\]
6.6 For product which do not contain skin / rind:

\[
\text{Collagen : Protein Ratio (CPR)} = \frac{(F \times C \text{ fat}) + (L \times C \text{ lean})}{6.25 \times ((F \times N \text{ fat}) + (L \times N \text{ lean}))}
\]

6.7 The AMC papers in Table 1 contain the data needed to carry out the calculations in 6.5 and 6.6 for some meat species. The data on standard errors in these publications can be used to estimate the standard error of the collagen protein ratios using propagation of error calculations.

6.8 For the range of lean meat contents required by law, 50 to 100% of the required/declared meat content, and for red meat species encountered these calculations are interpreted in a graphical format in figures 4 to 7. The graphs also show error bars of ±3 standard errors. The ratio of collagen to total protein in fatty tissue is higher than the ratio in muscle tissue, so as the proportion of fatty tissue in the meat content of a meat product increases the collagen to total protein ratio also increases.

6.9 For the data relating to rind-on pork it has been assumed that rind is present at a level of 10%, the maximum amount found in the pork cuts used. If details of the product suggest a rind level of less than 10% then the calculations need to be adjusted accordingly.
Variation of Collagen : Protein Ratio with Lean Meat Content for Pork Meat Products (including 10% Rind in the Total Meat)

Ranges are based on 3 x std error; trial involved 38 sides of pork

Figure 4
Variation of Collagen : Protein Ratio with Lean Meat Content for Rindless Pork Meat Products

Ranges are based on 3 x std error; trial involved 38 sides of pork

Figure 5
Variation of Collagen : Protein Ratio with Lean Meat Content for Clean Beef Meat Products

Data taken from Analyst, 1993, Vol 118, p 1217
Range based on 3 x std error; trial involved 43 sides of beef

Figure 6
Variation of Collagen : Protein Ratio with Lean Meat Content for Sheep Meat Products

Range based on 3 x std error trial; involved 81 lamb and 45 mutton sides

Figure 7
6.10 In the case of meat products analysed for enforcement purposes the prescribed minimum lean meat content as a proportion of the total meat content will be 50% or 65%. By reference to figures 4 to 7 limiting collagen : protein ratios for these lean meat contents can be recommended for use in the meat content calculations at 5.4. In the absence of an independent method of analysis to determine the lean meat content these values relate to products at the limit of legal compliance with respect to collagen content and their use will ensure that meat products manufacturers are not disadvantaged. If an independent estimate of the lean meat content is available then a more appropriate value for the ratio can be selected from figures 4 to 7.

6.11 The Association recommends that its members use mean collagen : protein ratios to estimate the most probable meat content.

6.12 When the nature of the meat ingredient is known then the most appropriate collagen protein ratio can be found from figures 4 to 7 having regard to the required minimum lean meat content as a proportion of the total meat content. In other cases it is recommended that the mean collagen protein ration for the whole carcass is used (table 2).

**Table 2**

**Recommended Limiting Collagen : Protein Ratios for Meat Products in which the Cut of Meat is Unknown**

<table>
<thead>
<tr>
<th>MEAT INGREDIENT</th>
<th>REQUIRED MINIMUM LEAN MEAT CONTENT AS A PROPORTION OF THE TOTAL MEAT CONTENT 50%</th>
<th>REQUIRED MINIMUM LEAN MEAT CONTENT AS A PROPORTION OF THE TOTAL MEAT CONTENT 65%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pork with rind</td>
<td>0.35</td>
<td>0.29</td>
</tr>
<tr>
<td>Pork without rind</td>
<td>0.24</td>
<td>0.18</td>
</tr>
<tr>
<td>Beef</td>
<td>0.28</td>
<td>0.21</td>
</tr>
<tr>
<td>Lamb</td>
<td>0.17</td>
<td>0.14</td>
</tr>
<tr>
<td>Mutton</td>
<td>0.18</td>
<td>0.15</td>
</tr>
</tbody>
</table>

6.13 Appropriate allowances must be made for meat ingredients which may legitimately contribute to the meat content and which may contain naturally elevated proportions of collagen e.g. jowl, masseter, diaphragm.
7. **Worked Examples**

7.1 The ingredient list accompanying a can of pork luncheon meat was:

Ingredients: Pork, Water, Starch, Salt, Caseinates, Soya Protein, Triphosphates, Spices, Antioxidant (E3101), Preservative (E250), Colour (E127). Minimum 80 % meat

7.2 The analytical results were as follows

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Result 1</th>
<th>Result 2</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat</td>
<td>25.59</td>
<td>25.82</td>
<td>25.71</td>
</tr>
<tr>
<td>Moisture</td>
<td>52.56</td>
<td>52.52</td>
<td>52.54</td>
</tr>
<tr>
<td>Ash</td>
<td>3.39</td>
<td>3.37</td>
<td>3.38</td>
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<tr>
<td>Nitrogen</td>
<td>2.310</td>
<td>2.290</td>
<td>2.300</td>
</tr>
<tr>
<td>Hydroxyproline</td>
<td>0.697</td>
<td>0.690</td>
<td>0.693</td>
</tr>
<tr>
<td>Soya Protein</td>
<td>0.42</td>
<td>0.42</td>
<td>0.42</td>
</tr>
<tr>
<td>Casein</td>
<td>0.91</td>
<td>1.13</td>
<td>1.02</td>
</tr>
<tr>
<td>Carbohydrate (difference)</td>
<td></td>
<td></td>
<td>4.0</td>
</tr>
</tbody>
</table>

A correction for the nitrogen associated with the carbohydrate is not appropriate in this example as the carbohydrate was established to be starch.

**EXAMPLE 1 - ALL OF THE COLLAGEN COUNTS AS MEAT**

7.3 If all of the collagen is to be allowed to count towards the meat content then the calculation at 4.3 can be used

7.3.1

\[
% \text{DFM} = \frac{(N_t - N_c) \times 100}{N_{ff}}
\]

7.3.2

\[
\text{Soya Nitrogen} = \frac{0.42}{6.25} = 0.067\%
\]

7.3.3

\[
\text{Casein Nitrogen} = \frac{1.02}{6.36} = 0.160\%
\]

7.3.4 In the absence of any information about the nature of the pork ingredient the mean fat free nitrogen factor for a side of pork, 3.50, is appropriate (Table 1, Figure 2)
7.3.5 \[ \% \text{DFM} = \frac{2.300 - 0.067 - 0.160 \times 100}{3.50} = 59.2\% \]

7.3.6 % Lean Meat is the lesser of:
\[
\begin{align*}
\text{LM} &= \% \text{DFM} \times \frac{100}{90} = 65.8\% \\
\text{or} \\
\text{LM} &= \% \text{DFM} + \text{Total Fat} = 85.91
\end{align*}
\]
\[\therefore \% \text{Lean Meat} = 65.8\%\]

7.3.7 The minimum lean meat required for pork luncheon meat is 65 % of the total required / declared meat content which in this case amounts to:

\[
65\% \text{ of } 80 = 52\%
\]

The sample is therefore satisfactory with respect to its lean meat content.

7.3.8 The % Total Meat is the lesser of:
\[
\begin{align*}
\text{TM} &= \frac{\text{LM} \times 100}{\text{LM min}} = 101\% \\
\text{or} \\
\text{TM} &= \text{DFM} + \text{Total Fat} = 84.0\%
\end{align*}
\]

In this example the lean meat content as a proportion of the total meat content is 77 % and is in excess of the minimum required amount of 65 %. There is therefore no additional fat over and above that accounted for by the meat content and all of the fat has been included in the total meat content.

\[\therefore \% \text{Total Meat} = 84.9\%\]

7.3.9 The minimum total meat content declared on the label was 80 % and the sample is therefore satisfactory with respect to its **total meat content.**
Example 2 - The Collagen in the Meat Content is Restricted to that Naturally Associated with the Meat Used

7.4 If the collagen allowed to count towards the meat content is restricted then the calculation at 5.4.5 can be used

\[
\% \text{ DFM} = \frac{(N_t - N_c - (1.28 \times \text{OHP})) \times 100}{(1 - \text{CPR}) \times N_{ff}}
\]

7.4.1 As before:

<table>
<thead>
<tr>
<th>Analyte</th>
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</tr>
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<td>0.690</td>
<td>0.693</td>
</tr>
<tr>
<td>Soya Protein</td>
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<td>0.42</td>
<td>0.42</td>
</tr>
<tr>
<td>Casein</td>
<td>0.91</td>
<td>1.13</td>
<td>1.02</td>
</tr>
<tr>
<td>Carbohydrate (difference)</td>
<td></td>
<td></td>
<td>4.0</td>
</tr>
</tbody>
</table>

\[
\text{Soya Nitrogen} = \frac{0.42}{6.25} = 0.067\%
\]

\[
\text{Casein Nitrogen} = \frac{1.02}{6.38} = 0.160\%
\]

\[
N_c = 0.067 + 0.160 = 0.227\%
\]

7.4.2 Further enquiries of the manufacturer have shown that pork neck with rind on has been used in this product. Reference to figure 2 shows that a mean fat free nitrogen factor is therefore 3.38.

7.4.3 Reference to figure 4 shows that the mean collagen : protein ratio is 0.31 for a product with a minimum prescribed lean meat content as a proportion of the total meat content of 65% and containing pork neck with rind on.

7.4.4

\[
\% \text{ DFM} = \frac{(N_t - N_c - (1.28 \times \text{OHP})) \times 100}{(1 - \text{CPR}) \times N_{ff}}
\]

\[
\% \text{ DFM} = \frac{2.300 - 0.227 - (1.28 \times 0.693) \times 100}{(1 - 0.31) \times 3.38%}
\]

\[
\% \text{ DFM} = 50.9%
\]
7.4.5 Lean Meat is the lesser of:

\[
\text{LM} = \frac{\text{DFM} \times 100}{90} = 56.6
\]

or

\[
\text{LM} = \text{DFM} + \text{Total Fat} = 76.6
\]

\[
\therefore \text{Lean Meat} = 56.6\%
\]

7.4.6 The minimum lean meat required for pork luncheon meat is 65% of the total required / declared meat content which in this case amounts to:

\[
65\% \text{ of } 80 = 52\%
\]

The sample is therefore satisfactory with respect to its lean meat content.

7.4.7 % Total meat is the lesser of

\[
\text{TM} = \frac{\text{LM} \times 100}{\text{LM min}} = 87.0\%
\]

or

\[
\text{TM} = \text{DFM} + \text{Total Fat} = 76.6\%
\]

In this example the lean meat content as a proportion of the total meat content is 74% and is in excess of the minimum required amount of 65%. There is therefore no additional fat over and above that accounted for by the meat content and all of the fat has been included in the total meat content.

\[
\therefore \text{Total Meat} = 76.6\%
\]

7.4.8 The minimum total meat content declared on the label was 80% and the sample is therefore unsatisfactory with respect to its total meat content. In deciding whether formal action was appropriate on the basis of these results due regard should be had to the reliability of the result obtained.

7.4.9 The collagen protein ratio is calculated as at 5.2

\[
\text{Collagen : Protein Ratio (CPR)} = \frac{\% \text{ Hydroxyproline } \times 8}{\% \text{ Total Meat Nitrogen } \times 6.25}
\]

\[
\text{Collagen : Protein Ratio (CPR)} = \frac{0.693 \times 8}{6.25 \times (2.300 - 0.227)} = 0.43
\]

Figure 4 shows that pork neck with rind on having a lean meat content of 65% of the total meat content has a collagen : protein ratio of 0.31. The sample therefore contains
collagen over and above that associated with the meat content. The additional collagen can be calculated from 5.4.8

\[
\text{Excess Collagen} = \frac{\text{Total Collagen} - \frac{\text{Total Protein} - \text{Total Non-Meat Protein} - \text{Total Collagen}}{1 - \text{CPR}}}{(1 - \text{CPR})}
\]

\[
\text{Excess Collagen} = 8 \times \text{OHP} - \frac{\text{CPR} \times (6.25 \times \text{Nt} - \text{Total Non-Meat Nitrogen} - 8 \times \text{OHP})}{1 - \text{CPR}}
\]

\[
\text{Excess Collagen} = (8 \times 0.693) - \frac{0.31(6.25 \times 2.3) - (0.42 + 1.02) - (8 \times 0.693)}{(1 - 0.31)}
\]

Excess Collagen = 2.2

where Excess Collagen is expressed as a percentage of the sample

The sample therefore contains 2.2% of dry collagen in excess of that naturally associated with pork leg with rind on.

7.4.10 Reference to AMC data on pork rind (Analyst, 1996, Vol 121, p 573) shows that the average hydroxyproline content of fat free pork neck rind is 4.33%

So:

\[
\text{Collagen in pork neck rind} = 8 \times \text{Hydroxyproline}
\]

\[
\text{Collagen in pork neck rind} = 8 \times 4.33 = 34.6\%
\]

This sample contains 2.2% additional collagen which is equivalent to the presence of

\[
\frac{2.2 \times 100}{34.6} = 6.4\% \text{ of pork neck rind}
\]

This additional collagen, which is over and above the amount naturally associated with the flesh used cannot count towards the meat content and must be separately declared in the list of ingredients.
Example 3 - The Collagen in the Meat Content is Restricted to that Naturally Associated with the Meat Used and the Sample Contains Fat at a Level Greater than that Permitted to Count towards the Meat Content

7.5 As with Example 2 the collagen allowed to count towards the meat content is restricted and the calculation at 5.4.5 can be used:

\[
DFM = \frac{(Nt - Nc - (1.28 \times OHP)) \times 100}{(1 - CPR) \times Nff}
\]

7.5.1 The analytical results were as follows

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Result 1</th>
<th>Result 2</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat</td>
<td>32.76</td>
<td>32.96</td>
<td>32.86</td>
</tr>
<tr>
<td>Moisture</td>
<td>52.56</td>
<td>52.52</td>
<td>52.54</td>
</tr>
<tr>
<td>Ash</td>
<td>3.39</td>
<td>3.37</td>
<td>3.38</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>1.820</td>
<td>1.780</td>
<td>1.800</td>
</tr>
<tr>
<td>Hydroxyproline</td>
<td>0.525</td>
<td>0.535</td>
<td>0.530</td>
</tr>
<tr>
<td>Soya Protein</td>
<td>0.42</td>
<td>0.42</td>
<td>0.42</td>
</tr>
<tr>
<td>Casein</td>
<td>0.91</td>
<td>1.13</td>
<td>1.02</td>
</tr>
<tr>
<td>Carbohydrate (difference)</td>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

Soya Nitrogen = \frac{0.42}{6.25} = 0.067%

Casein Nitrogen = \frac{1.02}{6.38} = 0.160%

\[Nc = 0.067 + 0.160 = 0.227%\]

7.5.2 Pork neck with rind on has been used in this product. Reference to figure 2 shows that a mean fat free nitrogen factor is therefore 3.38.

7.5.3 Reference to figure 4 shows that the mean collagen : protein ratio is 0.31 for a product with a minimum prescribed lean meat content as a proportion of the total meat content of 65% and containing pork neck with rind on.

7.5.4

\[
DFM = \frac{(Nt - Nc - (1.28 \times OHP)) \times 100}{(1 - CPR) \times Nff}
\]

\[
DFM = \frac{1.800 - 0.227 - (1.28 \times 0.530) \times 100}{(1 - 0.31) \times 3.38}
\]

DFM = 38.4%
7.5.3 % Lean Meat is the lesser of:

\[
LM = \frac{DFM \times 100}{90} = 42.7\%
\]

or

\[
LM = DFM + \text{Total Fat} = 71.3\%
\]

7.5.6 The minimum lean meat required for pork luncheon meat is 65 % of the total required / declared meat content which in this case amounts to:

\[
65\% \text{ of } 80 = 52\%
\]

The sample is therefore unsatisfactory with respect to its lean meat content.

7.5.7 % Total meat is the lesser of

\[
TM = \frac{LM \times 100}{LM \text{ min}} = 65.6\%
\]

or

\[
TM = DFM + \text{Total Fat} = 71.3\%
\]

∴ Total Meat Content = 65.6%

7.5.8 The minimum total meat content declared on the label was 80 % and the sample is therefore unsatisfactory with respect to its total meat content. In deciding whether formal action is appropriate on the basis of these results due regard should be had to the reliability of the result obtained.

7.5.9 In this example the lean meat content as a proportion of the total meat content is 65 % which is equal to the minimum required amount of 65 %. There may therefore be additional fat over and above that accounted for in the meat content. Any additional fat is calculated as at 4.6

\[
\text{Excess Fat} = \text{Total Fat} - (\text{Total Meat} - \text{Defatted Meat})
\]

Excess Fat = 32.86 - (65.5 - 38.4) = 5.8%

This additional fat cannot count towards the meat content and must be declared separately in the list of ingredients.

7.5.10 The collagen protein ratio is calculated as at 5.2
Collagen : Protein Ratio (CPR) = \frac{\% \text{ Hydroxyproline} \times 8}{\% \text{ Total Meat Nitrogen} \times 6.25} \\
Collagen : Protein Ratio (CPR) = \frac{0.53 \times 8}{6.25 \times (1.800 - 0.227)} = 0.43\%

Figure 4 shows that pork neck with rind on having a lean meat content of 65\% of the total meat content has a collagen : protein ratio of 0.31. The sample therefore contains collagen over and above that associated with the meat content. The additional collagen can be calculated from 5.4.8:

| Excess Collagen = Total Collagen - \frac{\text{Total Protein} - \text{Total Non-Meat Protein} - \text{Total Collagen}}{(1 - \text{CPR})} |
| Excess Collagen = 8 \times \text{OHP} - \frac{\text{CPR} \times (6.25 \times \text{Nt} - \text{Total Non-Meat Nitrogen} - 8 \times \text{OHP})}{(1 - \text{CPR})} |
| Excess Collagen = (8 \times 0.53) - \frac{0.31(6.25 \times 1.8) - (0.42 + 1.02) - (8 \times 0.53)}{(1 - 0.31)} |
| Excess Collagen = 1.7 |

where Excess Collagen is expressed as a percentage of the sample.

The sample therefore contains 1.7\% of dry collagen in excess of that naturally associated with pork leg with rind on.

7.5.11 Reference to AMC data on pork rind ( Analyst, 1996, Vol 121, p573 ) shows that the average hydroxyproline content of fat free pork neck rind is 4.33 \%.

So collagen in pork neck rind = 8 \times \text{hydroxyproline} \\
= 8 \times 4.33 \\
= 34.6\%

This sample contains 1.7\% of additional collagen which is equivalent to the presence of:

\[
\frac{1.7 \times 100}{34.6} = 4.9\% \text{ of pork neck rind}
\]

This additional collagen, which is over and above the amount naturally associated with the flesh used cannot count towards the meat content and must be separately declared in the list of ingredients.