

8. Calculation of Meat Content

8.1 Introduction

The flow diagram (Section 8.3) outlines the method to calculate the meat content of a meat product as per the Clitravi methodology and corresponds to the worked example in Section 8.4.

In order to calculate the meat content of a meat product, the percentage fat, connective tissue and meat protein content for each species must be determined either by analysis or from typical compositional values (Appendix 16).

The levels of fat, meat protein and hydroxyproline/collagen present in meat ingredients may be determined by analysis of representative samples of ingredients from the mixing bowl. After which, the percentage fat, meat protein and collagen in a specific part or mixture can be determined using ISO methods or equivalent.

Collagen is the analytical parameter by which the connective tissue content is assessed. In order to determine the connective tissue content, the ratio of the collagen content to protein content is analysed. When the collagen content is determined it needs to be converted to connective tissue.

Conversion Factor: Connective tissue content = Collagen x 37/8 (i.e. 4.625)

The ratio 37/8 represents the conversion from collagen to connective tissue (*Source: Campden and Chorleywood – Guideline 22 ‘Meat and meat products: the calculation of meat content, added water and connective tissue from analytical data’*).

8.2 Terminology

% LIMIT_{FAT} The limit for the fat content is the percentage of fat permitted in a ‘meat’ mixture for a particular species as defined in Regulation (EC) No. 1196/2011. For example, the % LIMIT_{FAT} for pork is the legal limit of fat allowed in the pork ‘meat’ mixture i.e. 30%.

% LIMIT_{COL} The limit for the connective tissue content, expressed as collagen, is the percentage of connective tissue permitted in a ‘meat’ mixture for a particular species as defined in Regulation (EC) No. 1196/2011. For example the % LIMIT_{COL} for pork is the legal limit of connective tissue allowed in the pork ‘meat’ mixture i.e. 25%.

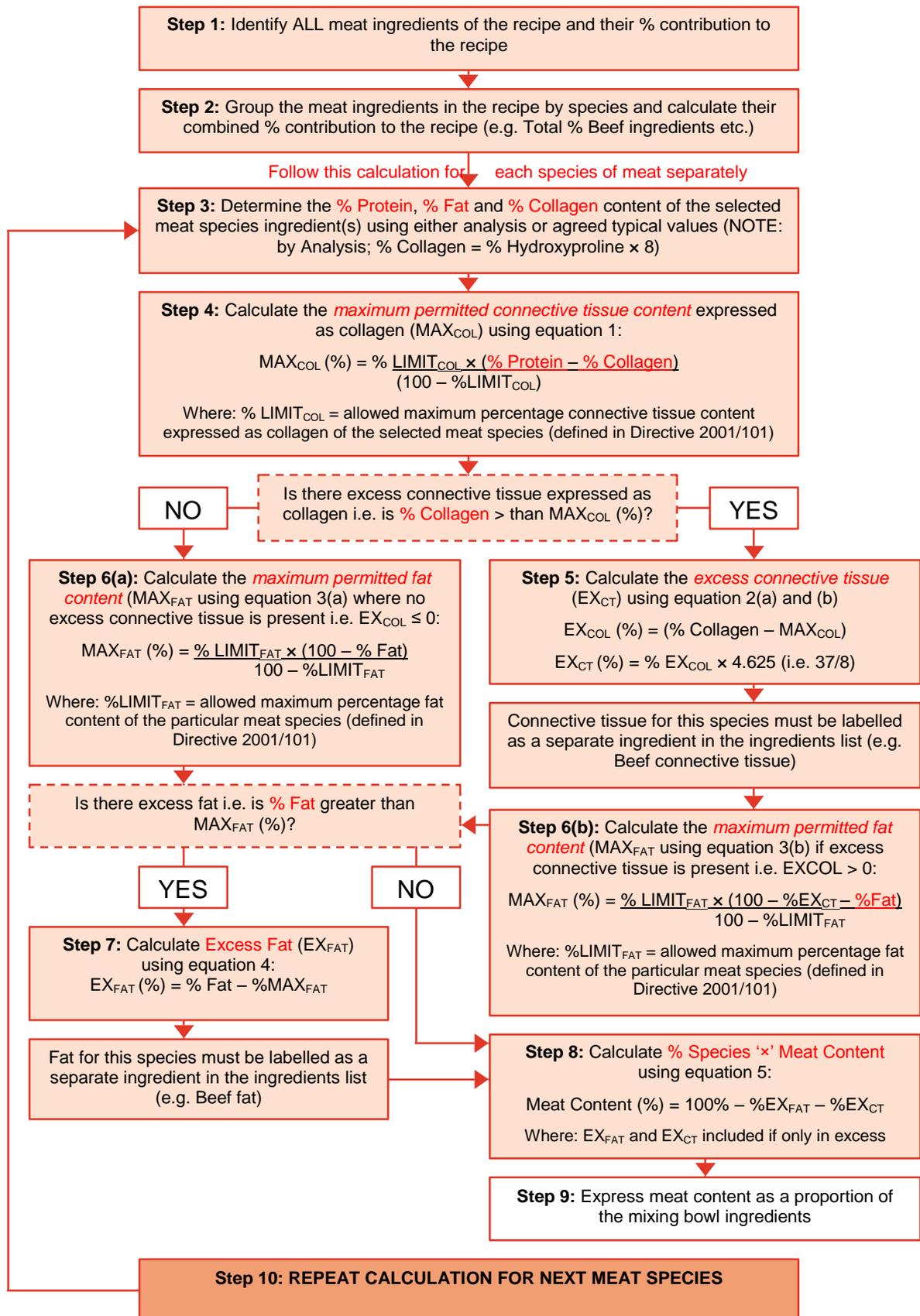
MAX_{FAT} The maximum fat content is the amount of fat tolerated in a ‘meat’ mixture for a particular species in order for the mixture to be defined as ‘meat’ in the list of ingredients. It is expressed as a proportion of the ‘meat’ components only.

MAX_{COL} The maximum connective tissue content, expressed as collagen, is the amount of connective tissue tolerated in a meat mixture for a particular species in order for the mixture to be defined as ‘meat’ in

the list of ingredients. It is expressed as collagen as a proportion of the 'meat' mixture components only.

% EX _{COL}	Excess collagen
% EX _{CT}	Corresponding excess connective tissue
% EX _{FAT}	Excess fat
MEAT	Meat content covered by the definition of meat

8.3 Flow Diagram for the Calculation of Meat Content



8.4 Worked Example: Meat Content Calculation - Pork Liver Sausage

Step 1:

Determine the product composition at the level of mixing bowl and identify all meat ingredients and their percentage contribution to the recipe

(a) Recipe at mixing bowl

Kg	Ingredient	%
43.8	Pork neck, 85VL including rind	12
29.2	Pork loin, 85VL including rind	8
127.7	Pork backfat	35
7.3	Nitrite salt	2
36.4	Pork liver	10
7.3	Pork meat extract	2
10.9	Pork rind less trimmable fat	3
7.3	Pork gelatine	2
54.7	Beef cuts	15
10.9	Beef fat	3
10.9	Chicken liver	3
7.3	Herbs, spices, additives, HVP's	2
7.3	Sodium caseinate	2
3.7	Pork casing	1
364.7	Totals	100

(b) Identify the different meat cuts

Pork neck, 85VL including rind	= meat	12%
Pork loin, 85VL including rind	= meat	8%
Pork backfat	= meat*	35%
Nitrite salt	= not meat	
Pork liver	= not meat	
Pork meat extract	= not meat	
Pork rind less trimmable fat	= meat	3%
Pork gelatine	= not meat	
Beef cuts	= meat	15%
Beef fat	= meat	3%
Chicken liver	= not meat	
Herbs, spices, additives, HVP's	= not meat	
Sodium caseinate	= not meat	
Pork casing	= not meat	

(*include added fat)

Step 2:

Group meat cuts in the recipe by species and calculate their combined percentage contribution to the recipe

Pork neck, 85VL including rind	12%
Pork loin, 85VL including rind	8%
Pork backfat	35%
Pork rind less trimmable fat	3%
Pork 'Meat' Mixture	58%

Beef cuts	15%
Beef fat	3%
Beef 'Meat' Mixture	18%

Step 3:

Determine % Protein, % Fat and % Collagen content for each species

The collagen, fat and protein content must be determined using analytical methods or by reference to generally accepted compositional tables. If using generally accepted compositional data, the typical values for protein, fat and collagen in meat cuts compositional tables provided for in the FSA UK guidance note may be used. The typical values provided in the FSA UK guidance note are also outlined in Appendix 16 of this guidance note.

Care must be taken to exclude the following from the calculation/analysis:

- All non-meat cuts (e.g. pork liver)
- All non -meat nitrogen/protein sources (e.g. pork stock, caseinates, Hydrolysed Vegetable Protein)
- All non-meat collagen (e.g. pork gelatine, pork casing)
- All non -meat fat (e.g. refined fats, pork stock)

WORKED EXAMPLE:

Determination of Total % Protein for each species

PORK

The pork ingredients can be listed as follows, with their corresponding % protein. The % protein for this example is determined from the reference compositional Table in Annex 16.

Meat cut	% Present		% Protein	
Pork neck 85VL including rind	12%	A	17.4%	a
Pork loin 85VL including rind	8%	B	18.9%	b
Pork backfat	35%	C	5.1%	c
Pork rind less trimmable fat	3%	D	34.5%	d

Values in the table above have been denoted a letter for the purposes of the following formula. The formula below can be modified to include more or less ingredients i.e. (E x e) + (F x f) etc.

$$\text{Total \% Protein} = \frac{(A \times a) + (B \times b) + (C \times c) + (D \times d) \text{ etc.}}{100}$$

$$\begin{aligned} \text{Total \% Protein} &= \frac{(12 \times 17.4) + (8 \times 18.9) + (35 \times 5.1) + (3 \times 34.5)}{100} \\ &= \frac{208.8 + 151.2 + 178.5 + 103.5}{100} \\ &= \mathbf{6.42\% \text{ Protein in the Pork 'Meat' Mixture}} \end{aligned}$$

BEEF

The same calculation can be used to calculate the total % protein in the Beef 'Meat' Mixture.

Meat cut	% Present		% Protein	
Beef brisket lean	15%	A	16.3%	a
Beef fat	3%	B	7.3%	b

$$\begin{aligned}\text{Total \% Protein} &= \frac{(15 \times 16.3) + (3 \times 7.3)}{100} \\ &= \frac{244.5 + 21.9}{100} \\ &= \mathbf{2.66\% \text{ Protein in the Beef 'Meat' Mixture}}\end{aligned}$$

Determination of Total % Fat for each species

PORK

The pork ingredients can be listed as follows, with their corresponding % fat. The % fat for our example is determined from the reference compositional Table in Annex 16.

Meat cut	% Present		% Fat	
Pork neck 85VL including rind	12%	A	21.1%	a
Pork loin 85VL including rind	8%	B	22.5%	b
Pork backfat	35%	C	78.6%	c
Pork rind less trimmable fat	3%	D	10.0%	d

Values in the table above have been denoted a letter for the purposes of the following formula. The formula below can be modified to include more or less ingredients i.e. (E × e) + (F × f) etc.

$$\text{Total \% Fat} = \frac{\mathbf{(A \times a) + (B \times b) + (C \times c) + (D \times d) \text{ etc.}}}{\mathbf{100}}$$

$$\begin{aligned}\text{Total \% Fat} &= \frac{(12 \times 21.1) + (8 \times 22.5) + (35 \times 78.6) + (3 \times 10)}{100} \\ &= \frac{253.2 + 180 + 2,751 + 30}{100} \\ &= \mathbf{32.14\% \text{ Fat in the Pork 'Meat' Mixture}}\end{aligned}$$

BEEF

The same calculation can be used to calculate the total % fat in the Beef 'Meat' Mixture.

Meat cut	% Present		% Fat	
Beef brisket lean	15%	A	27.6 %	a
Beef fat	3%	B	74.8%	b

$$\text{Total \% Fat} = \frac{(15 \times 27.6) + (3 \times 74.8)}{100}$$

$$= \frac{414 + 224.4}{100}$$

$$= 6.38\% \text{ Fat in the Beef 'Meat' Mixture}$$

Determination of Total % Collagen for each species

PORK

The pork ingredients can be listed as follows, with their corresponding % Collagen. The % Collagen for our example is determined from the reference compositional Table in Annex 16.

Meat cut	% Present		% Collagen	
Pork neck 85VL including rind	12%	A	3.12 %	a
Pork loin 85VL including rind	8%	B	3.76%	b
Pork backfat	35%	C	3.68%	c
Pork rind less trimmable fat	3%	D	22.4%	d

Values in the table above have been denoted a letter for the purposes of the following formula. The formula below can be modified to include more or less ingredients i.e. $(E \times e) + (F \times f)$ etc.

$$\text{Total \% Collagen} = \frac{(A \times a) + (B \times b) + (C \times c) + (D \times d) \text{ etc.}}{100}$$

$$\text{Total \% Collagen} = \frac{(12 \times 3.12) + (8 \times 3.76) + (35 \times 3.68) + (3 \times 22.4)}{100}$$

$$= \frac{37.44 + 30.08 + 128.8 + 67.2}{100}$$

$$= 2.64\% \text{ Collagen in the Pork 'Meat' Mixture}$$

BEEF

The same calculation can be carried out to calculate the total % collagen in the Beef 'Meat' Mixture.

Meat ingredient	% Present		% Collagen	
Beef brisket lean	15%	A	2.56 %	a
Beef fat	3%	B	5.76%	b

$$\text{Total \% Collagen} = \frac{(15 \times 2.56) + (3 \times 5.76)}{100}$$

$$= \frac{38.4 + 17.28}{100}$$

$$= \mathbf{0.56\% \text{ Collagen in the Beef 'Meat' Mixture}}$$

We now have the following values determined for our pork and beef 'meat' mix example;

Pork 'Meat' Mixture

Total % Protein =6.42%

Total % Fat =32.14%

Total % Collagen = 2.64%

Beef 'Meat' Mixture

Total % Protein = 2.66%

Total % Fat = 6.38%

Total % Collagen = 0.56%

These figures can be used to:

- Calculate the maximum permitted connective tissue
- Calculate excess collagen, if any
- Calculate excess connective tissue, if any
- Calculate the maximum permitted fat,
- Calculate excess fat, if any
- Calculate the meat content per species
- Express meat content as a proportion of the mixing bowl ingredients per species

However, one other set value is also required. Regulation (EU) No. 1169/2011 sets out maximum fat and connective tissue content for ingredients designated by the term 'meat'. This Regulation indicates:

Maximum limits of fat in pork is 30%

Maximum limits of connective tissue in pork is 25%

Maximum limits of fat in beef is 25%

Maximum limits of connective tissue in beef is 25%

We can now proceed to the calculation using Steps 4-9.

Step 4:

Calculate the maximum permitted connective tissue content, expressed as collagen (MAX_{COL}) using the following equation:

$$\% MAX_{COL} = \frac{\% LIMIT_{COL} \times (\% Protein - \% Collagen)}{(100 - \% LIMIT_{COL})}$$

Where $\%LIMIT_{COL}$ = the maximum percentage of connective tissue content expressed as collagen of the selected meat species as defined in Regulation (EU) No. 1169/2011.

Step 5:

(a) Calculate excess collagen (EX_{COL})

$$\% EX_{COL} = \% Collagen - \% MAX_{COL}$$

If the % excess collagen (EX_{COL}) is less than or equal to (\leq) 0%, there is no need for Step 5(b) as there is simply no excess.

If the % excess collagen is greater than ($>$) 0%, then Step 5(b) does apply. Since collagen is an analytical parameter by which connective tissue is assessed, the % excess collagen must be converted into % excess connective tissue (EX_{CT}). This is done using a conversion factor of 4.625, as per the equation below (Step 5(b)).

(b) Calculate excess connective tissue (EX_{CT})

$$\% EX_{CT} = \% EX_{COL} \times 4.625$$

WORKED EXAMPLE CONTINUED:

Calculate the maximum permitted connective tissue (% MAX_{COL}), excess collagen (% EX_{COL}) and excess connective tissue (% EX_{CT}) for each species

PORK

Protein = 6.42%

Fat = 32.14%

Collagen = 2.64%

Maximum limit of fat in pork (% $LIMIT_{FAT}$) = 30%

Maximum limit of connective tissue in pork (% $LIMIT_{CT}$) = 25%

$$\% \mathbf{MAX}_{COL} = \frac{25 \times (6.42 - 2.64)}{(100 - 25)}$$

$$= \frac{25 \times 3.78}{75}$$

$$= \mathbf{1.26\%}$$

$$\% \mathbf{EX}_{COL} = 2.64\% - 1.26\%$$

$$= \mathbf{1.38\%}$$

$$\% \mathbf{EX}_{CT} = 1.38\% \times 4.625$$

$$= \mathbf{6.38\%}$$

There is **6.38%** excess connective tissue that cannot be considered as 'Pork Meat' in the list of ingredients, but must be declared as 'Pork Connective Tissue' on the label.

BEEF

Protein = 2.66%

Fat = 6.38%

Collagen = 0.56%

Maximum limit of fat (% $LIMIT_{FAT}$) in beef = 25%

Maximum limit of connective tissue in beef (% $LIMIT_{CT}$) = 25%

$$\% \mathbf{MAX}_{COL} = \frac{25 \times (2.66 - 0.56)}{(100 - 25)}$$

$$= \frac{25 \times 2.1}{75}$$

$$= \mathbf{0.7\%}$$

$$\begin{aligned}\% \text{EX}_{\text{COL}} &= 0.56\% - 0.7\% \\ &= -0.14\%\end{aligned}$$

In this example, % EX_{COL} is ≤0%. Therefore, there is **no need for step 3** (% Excess connective tissue), as there is no excess collagen and therefore no excess connective tissue.

Step 6:

Calculate the maximum permitted fat content (% MAX_{FAT}) which is expressed as a proportion of the 'meat' components.

In order to do this, excess connective tissue (i.e. collagen) must first be excluded from the calculation, as it is not considered 'meat'.

For this reason there are two separate formulae **A** and **B**:

(A) If there is no excess collagen (≤0%) recorded in Step 5, the following formula applies:

$$\% \text{MAX}_{\text{FAT}} = \frac{\% \text{LIMIT}_{\text{FAT}} \times (100 - \% \text{Fat})}{(100 - \% \text{LIMIT}_{\text{FAT}})}$$

(B) If there is excess collagen (>0%) recorded in Step 5, the following formula applies:

$$\% \text{MAX}_{\text{FAT}} = \frac{\% \text{LIMIT}_{\text{FAT}} \times (100 - \% \text{EX}_{\text{COL}} - \% \text{Fat})}{(100 - \% \text{LIMIT}_{\text{FAT}})}$$

If % Fat (calculated in Step 3) is:

- greater (>) than the calculated % MAX_{FAT}, Step 7 applies
- less than (<) than the calculated % MAX_{FAT}, Step 7 does not apply

Step 7:

Calculate excess fat (% EX_{FAT}) content

Excess fat must be calculated and declared separately on the list of ingredients.

$$\% \text{EX}_{\text{FAT}} = \% \text{Fat} - \% \text{MAX}_{\text{FAT}}$$

WORKED EXAMPLE CONTINUED:

Calculate the maximum permitted fat content (MAX_{FAT}) for each species. This is expressed as a proportion of the 'meat' components

PORK

For the Pork 'Meat' Mixture there is an excess of collagen. Therefore, formula B of step 6 applies.

Pork 'Meat' Mixture

Protein = 6.42%

Fat = 32.14%

Collagen = 2.64%

Maximum limits of fat (MAX_{FAT}) in pork is 30%

Maximum limits of connective tissue (MAX_{CT}) in pork is 25%

Allowed collagen content (% MAX_{COL}) = 1.26%

Excess collagen (EX_{COL}) = 1.38%

Excess connective tissue (EX_{CT}) = 6.38 %

$$\begin{aligned}\% \mathbf{MAX}_{FAT} &= \frac{30 \times (100 - 1.38 - 32.14)}{(100 - 30)} \\ &= \frac{30 \times 66.48}{70} \\ &= \frac{1994.4}{70} \\ &= \mathbf{28.49\%}\end{aligned}$$

The fat content of the Pork 'Meat' Mixture is 32.14%, which is greater than the % Maximum amount of permitted fat of 28.49%, therefore there is excess fat, and step 7 applies:

$$\begin{aligned}\% \mathbf{EX}_{FAT} &= 32.14\% - 28.49\% \\ &= 3.65\%\end{aligned}$$

Therefore, there is **3.65% excess fat** that cannot be considered as 'Pork Meat' in the list of ingredients, but must be declared as 'Pork Fat' on the label.

BEEF

For the beef 'meat' mix there is no excess of collagen, therefore formula A of Step 6 applies.

Beef 'Meat' Mixture

Protein = 2.66%

Fat = 6.38%

Collagen = 0.56%

Maximum limits of fat ($LIMIT_{FAT}$) in beef is 25%

Maximum limits of connective tissue ($LIMIT_{CT}$) in beef is 25%

Allowed collagen content = 0.7%

Excess collagen (EX_{COL}) = 0%

Excess connective tissue (EX_{CT}) = 0%

$$\begin{aligned}\% \text{MAX}_{FAT} &= \frac{25 \times (100 - 6.38)}{(100 - 25)} \\ &= \frac{25 \times 93.62}{75} \\ &= 31.2\%\end{aligned}$$

The fat content of the beef 'meat' mixture is 6.38%, which is less than the % **Maximum amount of permitted fat of 31.2%**, therefore there will be no excess fat and Step 7 does not apply.

Step 8:

Calculate the meat content per species

$$\% \text{ Meat content} = 100\% - \%EX_{FAT} - \%EX_{CT}$$

In order to calculate the 'meat' content of the meat mixture per species, excess fat and excess connective tissue must be subtracted from the meat mixture as a whole. Meat can then be expressed as a proportion of the mixing bowl of ingredients, as per Step 9.

Step 9:

Express meat content as a proportion of the mixing bowl ingredients per species

$$\% \text{ Total 'meat' in recipe} = \frac{\% \text{ 'meat' per species in mixing bowl} \times \text{Meat content}}{100}$$

WORKED EXAMPLE CONTINUED:

Calculate the 'meat' content per species

PORK

Pork 'Meat' Mixture

Protein = 6.42%

Fat = 32.14%

Collagen = 2.64%

Maximum limits of fat in pork = 30%

Maximum limits of connective tissue in pork = 25%

Allowed collagen content = 1.26%

Excess collagen = 1.38%

Excess connective tissue = 6.38%

Maximum amount of permitted fat = 28.49%

Excess fat = 3.65%

$$\text{Pork 'Meat' Content} = 100\% - 3.65\% - 1.38\%$$

$$= \mathbf{94.97\%}$$

The pork 'meat' content as covered by the definition is 94.97%, but the other ingredients in the recipe must also be taken into account and the *meat content must be expressed as a proportion of the mixing bowl of ingredients*. The total pork 'meat' in recipe was calculated as 58%, of which 94.97% is meat. Therefore:

$$\text{Final Pork 'Meat' Content} = \frac{58 \times 94.97\%}{100}$$

(as a proportion of mixing bowl ingredients)

$$= \mathbf{55.08\%}$$

The final pork 'meat' content is calculated at **55.08%** and the final figures are as follows:

FINAL VALUES FOR PORK

'Meat' Content = 55.08%

Excess Connective Tissue = 6.38%

Excess Fat = 3.65%

BEEF

Beef 'Meat' Mixture

Protein = 2.66%

Fat = 6.38%

Collagen = 0.56%

Maximum limits of fat in beef in 25%

Maximum limits of connective tissue in beef is 25%

Allowed collagen content = 0.7%

Excess collagen = 0%

Excess connective tissue = 0%

Maximum amount of permitted fat = 31.2%

Excess fat = 0%

Beef 'meat' content = 100% - 0% - 0%

= 100%

The total beef 'meat' in the recipe was calculated as 18%, of which 100% is meat, so therefore the final figure for beef 'meat' is 18%.

Final beef 'meat' content = $\frac{18 \times 100\%}{100}$

= 18%

FINAL VALUES FOR BEEF

'Meat' content = 18%

Excess Connective Tissue = 0%

Excess Fat = 0%

Labelling

When all elements of Regulation (EU) No. 1169/2011 have been applied, the list of ingredients for Pork Liver Sausage could read as follows:

Ingredients:

Meat 73% (Pork, Beef)¹, Pork liver 10%, Pork fat, Chicken liver, Pork rind, Pork stock, Pork gelatine, Herbs, Salt, Milk proteins, Antioxidants: E330, E301, Spices,

Emulsifiers: E471, E72c, Hydrolysed vegetable proteins, Stabilisers: E450, E452, Pork casing, Beef fat, Beef connective tissue, Preservative: E250

Note¹: The % pork meat and beef meat could be declared separately under the list of ingredients