

# Calculation of the meat content in meat products

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## Abstract

Analytic investigation of the meat content as a constituent of meat products is described in the legislation and is based on determination of the nitrogen content in the given meat product and subsequent deduction of all non-protein sources. The given calculation must consider the maximum “permitted” content of fat and connective tissue in skeletal muscle. Knowledge of the correct parameters of meat for production is required when calculating the meat content as a constituent of meat products from their recipes. In view of the fact that frequent errors occur on labels declaring meat content, the aim of this work was to propose and evaluate a procedure for meat content calculation in meat products from the recipe of the given product.

*Labelling of meat products, meat content, meat for production*

## Introduction

The results of analyses of meat products performed by the supervisory bodies and large numbers of consumer tests continue to show that a considerable proportion of products are unsatisfactory in regard to their declared meat content. Inspections of the labels of meat products also continue to show the occurrence of errors in labelling the meat content as a constituent of meat products. The original definition of meat remains valid as a part of the legislation. This definition of meat as a foodstuff was drawn up for the purposes of hygiene and the protection of public health, and defines meat as all parts of animals fit for human consumption (Pipek 2002).

This definition does not, however, correspond to our ideas of what the term meat actually means to the consumer and, most importantly, fails to inform the consumer of the true nature of a meat product. The definition of meat as a constituent of meat products was, for this reason, created to inform the consumer in an accurate and comprehensible manner of the meat content as a constituent of a meat product.

The definition of meat as a constituent of meat products was formulated in 2001 by the European Commission Directive No. 2001/101/EC. This directive, which has been effective since 2003, obliges all EU member states to ensure that producers of meat products operating within their territory state the meat content on product labels in accordance with a newly harmonised definition that considers only skeletal muscle as a meat. This definition applies exclusively to the labelling of products that contain meat as a constituent part; it does not apply to the labelling of fresh meat and the body parts of animals that are sold without further processing. Meat is, then, defined as the skeletal muscle tissue of species of mammals and birds recognised as suitable for human consumption, along with tissue naturally contained in it or contiguous to it, as long as the total content of fat and connective tissue does not exceed the values given below (Table 1).

Mechanically-separated meat is excluded from this definition due to its consistency and other properties differing significantly from meat. Also heart, tongue, head muscles (other than the masticatory muscles), carpal muscle, talus muscle and tail are excluded. The diaphragm and masticatory muscles are, however, a considered part of the skeletal muscle. New requirements for the correct labelling of meat content appeared following the issuing

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of Regulation (EC) No. 1169/2011 of the European Parliament and of the Council on the provision of information about foodstuffs to the consumer which is entering into validity.

Table 1. The highest permissible content of fat and connective tissue in meat destined as a constituent in the production of meat products

Type of meat	Fat content <sup>2</sup> (max. % by weight)	Connective tissue content <sup>3</sup> (max. % by weight)
Meat of mammals <sup>1</sup>	25	25
Pork meat	30	25
Poultry and rabbit meat	15	10

<sup>1</sup>With the exception of rabbit and pork and mixes of different kinds of meat with a predominance of mammal meat

<sup>2</sup>If the given values for highest permissible content of fat and connective tissue are exceeded, though all other criteria for the definition of meat are fulfilled, the stated content of types of meat must be reduced accordingly and the presence of fat and/or connective tissue given in the product composition in addition to the meat.

<sup>3</sup>The content of connective tissue from the ratio between the collagen content and muscle protein content. The collagen content is understood as the content of hydroxyproline multiplied by a factor of eight.

### The laboratory determination of meat content

Laboratory procedures for the determination of the meat and fat content in meat products are stipulated in the European legislation, specifically Commission Regulation (EC) No. 2004/2002 on the procedure for determining the meat and fat content in certain products made with pork meat. This procedure has been gradually expanded to include other types of meats. The meat content is determined as the sum of defatted (fat-free) meat and fat originating from meat. The results of laboratory determination are given in percent of meat content without differentiating the kind of meat.

Meat content (%) = DM + F

DM =  $(N_T - N_x) / f \times 100$

Where:

DM = content of defatted meat (%)

F = total fat content (%)

$N_T$  = total nitrogen content determined by analysis (% by weight)

$N_x$  = nitrogen not originating from meat (% by weight)

$f$  = average nitrogen content (% by weight) in lean meat contained in the product. The value of this coefficient varies for different types and cuts of meat. Examples of values of the conversion factor are given in Table 2.

For the purposes of adjusting the value of nitrogen not originating from meat ( $N_x$ ), it is

Table 2. Average nitrogen content in selected types of meat

Type of meat	f [%]
Leg of pork	3.50
Shoulder of pork	3.35
Beef	3.65
Mutton	3.50
Chicken	3.50

necessary to know the quantity of each ingredient containing nitrogen and the nitrogen content in these ingredients. Examples of the nitrogen content in ingredients used in meat products are given in Table 3. This list is not, however, exhaustive in view of the use of a large number of animal and plant materials and additives that do not,

of course, meet the definition of meat as a skeletal muscle (as in the case of mechanically-separated meat). During this calculation, it is essential not to forget to correct the values for the maximum content of fat and connective tissue in accordance with Table 1.

Table 3. The content of nitrogen in a number of selected non-meat ingredients that contain nitrogen and that may occur in meat products

Non-meat constituents of meat products	Nitrogen [%]
Casein	15.8
Sodium caseinate	14.8
Isolate of soya protein	14.5
Soya with modified texture	8.0
Soya flour	8.0
Monosodium glutamate (MSG)	8.3
Cereals (flour, breadcrumbs, etc.)	2.0
Beef liver	2.7
Beef tongue	3.0

#### Calculation from laboratory values

An example of a calculation from analytic values for a meat product comprised of pork and beef.

The following analytic parameters were measured for the meat product:

Protein content:  $P = 10.4$

Fat content:  $F = 35.7$

Water content:  $M = 47.9$

Ash content:  $A = 3.2$

Hydroxyproline content:  $H = 0.3$

Calculated collagen content:  $C = 2.4$

CHO – imputed saccharide content

The example is simplified, for which reason a single source of extraneous nitrogen from cereals is assumed. These are imputed as the content of saccharides by subtracting the content of water, fat, protein and ash from the entire meat product.

The content of saccharides in meat:

$$CHO = 100 - M - F - P - A$$

$$CHO = 2.8\%$$

The content of nitrogen in meat is given as the proportion of the content of protein and a factor for calculation of the protein content in meat of 6.25. The nitrogen content in the meat  $N_M$  in  $\text{g} \cdot 100 \text{ g}^{-1}$  is calculated by subtracting all other non-meat sources of protein nitrogen from total nitrogen. In this case, this means merely  $N_R$  – nitrogen from cereals:

The content of nitrogen in meat ( $N_M$ ):

$N$  – total nitrogen content according to Kjeldahl

$$N = 10.4 / 6.25$$

$$N = 1.664\%$$

$N_R$  – nitrogen content from cereals

$$N_R = CHO \times 0.02$$

$$N_R = 0.056\%$$

$$N_M = N - N_R$$

$$N_M = 1.608\%$$

The determination of whether correction to the content of connective tissue is performed.

Content of connective tissue (CT):

$C$  – collagen content

$$CT = \frac{(C \times 100)}{(N_M \times 6.25)}$$

$$CT = \frac{(2.4 \times 100)}{(1.608 \times 6.25)}$$

$$CT = 23.88\%$$

The limit stipulated in the legislation for the content of connective tissue has not been exceeded. Correction for collagen content does not have to be performed, and  $N_M$  is used for calculation of the content of defatted meat.

Content of defatted (fat-free) meat (DFM):

$$DFM = \frac{N_M}{f} \times 100$$

$$DFM = \frac{1.608}{3.5} \times 100$$

$$DFM = 45.9\%$$

Content of permitted fat ( $F_{\text{permitted}}$ )

The permitted fat content in the product is determined from the content of defatted meat.

$F_{\text{maximum}}$  – stipulated by the legislation (30% for pork meat)

$$F_{\text{permitted}} = \frac{DFM \times F_{\text{max}}}{100 - F_{\text{max}}}$$

$$F_{\text{permitted}} = \frac{45.9 \times 30}{100 - 30}$$

$$F_{\text{permitted}} = 45.9\%$$

Meat content (MC):

DFM – content of defatted meat

$F$  – content of fat in the meat (measured if the limit or  $F_{\text{permitted}}$  has not been exceeded)

$$MC = DFM + F$$

$$MC = 45.9 + 19.7$$

$$MC = 65.6\%$$

The resultant meat content in the meat product is 65.6%.

### Calculating the content of meat from the recipe of a meat product

It is clear that, in spite of simplification of the corresponding procedures, the analytic determination of meat content is a relatively complicated and, more importantly, costly business. It is impossible to verify each product and each batch in the laboratory. The laboratory composition should serve merely to verify the accuracy of the procedures performed and the correctness of recipes. It is, then, possible to calculate the content of meat from the recipe alone. The Czech Meat Processors Association provided a guide on its webpages in 2006.

Its “step-by-step guide to determine the content of meat in meat products” can be summarised in the following points:

1. Express the composition of the ingredients used in the given meat product according to its recipe.
2. Determine which of used ingredients meets the stipulated criteria for harmonised

definition of meat (water, additives and mechanically-separated meat must be excluded).

3. Assign the ingredients selected in the preceding step to individual groups depending on their origin (type of slaughter animal).

4. Determine the content of muscle protein, fat and collagen in each group.

5. First stipulate the maximum permissible content of connective tissue in each group.

6. Verify whether the maximum permissible content of connective tissue has been exceeded. If it has, the use of this material in production must be labelled on the meat product packaging (without its percentage by weight needing to be stated).

7. Determine the maximum permissible content of fat in each group.

8. Verify whether the maximum permissible fat content has been exceeded. If it has, the use of this material in production must be labelled on the meat product packaging (without its percentage by weight needing to be stated).

9. Determine the meat (muscle tissue) content in each group.

10. Express the result in dependence on the proportion of the given group in the meat product.

11. Repeat steps 4 to 10 separately for each group according to the stipulated limits for the content of fat and connective tissue in dependence on their origin (type of slaughter animals) (Katina 2014)

This procedure gives a fairly clear explanation of the way in which meat should be labelled as an ingredient. A problem arises in points 9 and 10 in terms of the ratio of the individual types of meats in the product. Coefficients for the calculation of meat content can help us in this determination. Their calculation is based on the definition of meat as an ingredient, which is given as the sum of defatted meat and fat originating from meat. Documentation for the calculation of these coefficients was obtained from the analytic parameters given in the Catalogue of Fresh and Production Meats issued by the Czech Meat Processors Association in 2004. Coefficients for the calculation of the meat content as constituents of meat products were calculated from these parameters, and are given in Tables 4 and 5.

The coefficients obtained in this way were used to calculate meat content from the recipes of meat products. A calculation from recipes for types of grilling sausage produced according to CSN 577115 and PN MP 301/85 recipes is given as an example (Table 6 and 7).

Table 4. Analytic parameters and coefficients for pork production meat

Samples	Type of meat	Water [%]	Fat [%]	Protein content [%]	Connective tissue [%]	Fat-free meat [%]	Protein content [%]	Max. permitted fat [%]	Meat coefficient	Calculation coefficient
P1	Specially processed pork	75.0	5.0	20.0	1.0	95.0	5.0	40.7	1.36	1.00
P2	Lean pork I – or special	73.0	8.0	19.0	2.9	92.0	15.3	39.4	1.31	1.00
P3	Lean pork I	70.0	11.0	19.0	2.9	89.0	15.3	38.1	1.27	1.00
P4	Lean pork II	62.0	22.0	16.0	1.7	78.0	10.6	33.4	1.11	1.00
P5	Skinless lean pork – lean flank	52.0	40.0	8.0	1.2	60.0	15.0	25.7	0.86	0.85
P6	Skinless lean pork – fatty flank	40.0	60.0	10.0	3.0	40.0	30.0	17.1	0.57	0.54
P7	Pork lard without skin <sup>1</sup>	17.0	78.0	5.0	2.5	22.0	50.0	9.4	0.31	0.24
P8	Pork lard without skin <sup>2</sup>	8.0	90.0	2.0	1.7	10.0	85.0	4.3	0.14	0.06
P9	Production pork with skin	25.0	70.0	5.0	2.5	30.0	50.0	12.9	0.43	0.32
P10	Pork lard without skin – flare fat <sup>3</sup>	40.0	50.0	10.0	3.0	50.0	30.0	21.4	0.71	0.60

<sup>1</sup>Fatty trimmings, raw solid lard; <sup>2</sup>Raw back lard; <sup>3</sup>Skinless flare fat – soft fat from the flank or flare fat

Table 5. Analytic parameters and coefficients for beef production meat

Samples	Type of meat	Water [%]	Fat [%]	Protein content [%]	Connective tissue [%]	Fat-free meat [%]	Protein content [%]	Max. permitted fat [%]	Meat coefficient	Calculation coefficient
B1	Specially processed beef	75.0	4.0	21.0	1.5	96.0	7.1	32.0	1.28	1.00
B2	Production rump beef	72.0	8.0	20.0	3.0	92.0	15.0	30.7	1.23	1.00
B3	Production beef forequarters	69.0	12.0	19.0	3.4	88.0	17.9	29.3	1.17	1.00
B4	Production beef forequarters	64.0	18.0	18.0	4.5	82.0	25.0	27.3	1.09	1.00
B5	Production beef forequarters	50.0	35.0	15.0	3.8	65.0	25.3	21.7	0.87	0.87

Table 6. Grilling sausages CSN 577115

Basic ingredients	Per 100 kg/product	Coefficient for the calculation of meat content	Meat content per 100 kg
Salted production beef forequarters – finely comminuted	35.5	1.0	35.5
Salted production pork with skin – finely comminuted	20.4	0.32	6.5
Salted head meat – finely comminuted	3.0	0.0	0.0
Salted pork skin – finely comminuted	1.5	0.0	0.0
Salted back lard – filler	27.0	0.06	1.6
Beef meat	35.5	-	35.5
Pork meat	51.9	-	8.2
The sum	87.4	-	43.7

Table 7. Fine grilling sausages PN MP 301/85

Basic ingredients	Per 100 kg/product	Coefficient for the calculation of meat content	Meat content per 100 kg
Salted production rump beef – finely comminuted	20.0	1.0	20.0
Production beef forequarters – finely comminuted	10.0	1.0	10.0
Salted lean pork – finely comminuted	20.0	1.0	20.0
Salted lean pork II – finely comminuted	10.0	1.0	10.0
Salted skinned lean pork – finely comminuted	8.0	0.85	6.8
Salted back lard – filler	35.0	0.06	2.1
Beef meat	30.0	-	30.0
Pork meat	73.0	-	38.9
The sum	103.0	-	68.9

The results show a clear difference between the expression of meat content as a product constituent (the definition of skeletal muscle) and the content of meat expressed according to the original definition. It is, for this reason, necessary when using production meat P5 to indicate on the product label that the product also contains pork fat (lard) in addition to meat, and to declare connective tissue (pork or beef collagen, skin) in addition to the fat content for meats designated P6–P10 and B5.

A clear difference between the two definitions of meat can be seen from the results. The results obtained according to the original definition, which defines meat as all parts of animals fit for human consumption, are, in comparison with the definition defining meat as a skeletal muscle, higher by the exceeded limits for the content of fat and connective tissue. This difference amounts to 50% and 33% in our examples.

### **Conclusions**

The use of the coefficients obtained from the analytic parameters of production meats for calculating the meat content as constituents of meat products is one aid that may be used by meat producers for the correct declaration of meat in a product. The use of these coefficients is, however, conditional to the correct classification of raw materials into the individual groups of production meat. Explaining the fact that even products properly labelled with a relatively low meat content (40%) may be high-quality products with a high meat content is a difficult task facing all those involved in the development, evaluation, production and distribution of meat products.

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