

4.7 Cutting and mixing in the cutter with frozen lean meat

It is not always possible for sausage producers in plants to use non-frozen lean meat for sausage production. For a wide variety of reasons it is often necessary to fall back on frozen lean meat.

The temperature course during freezing and thawing of meat

When meat is frozen, its inherent water has to change its aggregate condition from “liquid” to “solid”. This operation requires time and energy.

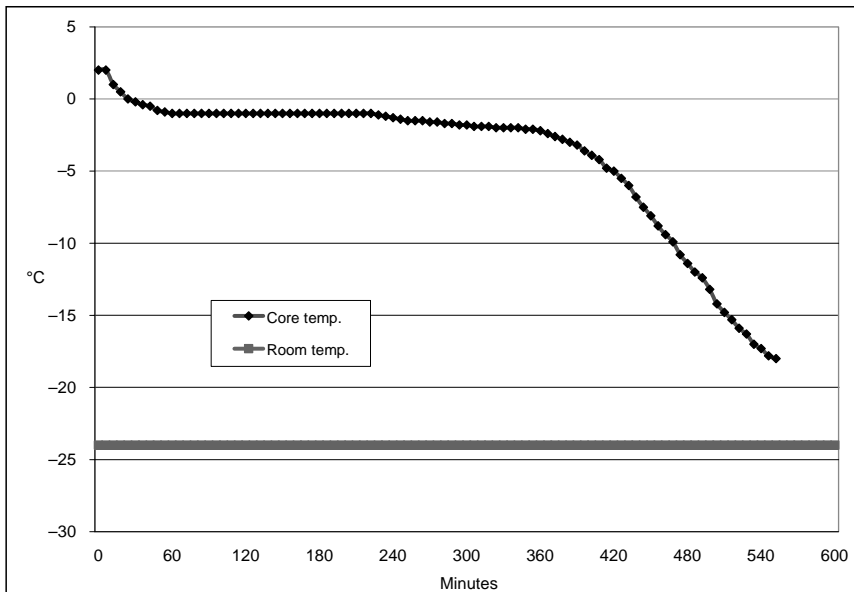


Diagram 12: Temperature course during freezing of a loin (cutlet) piece without bones at a temperature of -25 °C

Diagram 12 shows the temperature course in the core of a loin (cutlet) piece frozen at a room temperature of -25 °C. It can be seen clearly that the temperature drops quickly down to the freezing point of the meat at

approx. -1.5°C . It stays at this temperature for a very long time, and then (after 6 to 7 hours) quickly drops further. In the example described it took approx. 6 hours to fall below the “freezing point” of the meat. The same temperature course was observed during thawing of meat, only in the opposite direction. The temperature rises quickly from the base value of e.g. -20°C up to the freezing point of -1.5°C , then remains there until the “freezing point” is exceeded. Up to the time the freezing point is exceeded the meat is still frozen in this range.

The same process can be observed well when cutting frozen lean meat. The temperature rises quickly from the initial value to freezing point (see Diagram 12), then stays there until the freezing point is exceeded. It is only when the freezing point is exceeded that the meat is thawed. By adding common salt, the freezing point of the meat is reduced from -1.5°C to a lower value. The more salt is added to the meat, the lower its freezing point.

The cutting and mixing of raw sausage offers a good opportunity for observing the influence of common salt on the freezing point of meat. In this type of sausage, for reasons of processing technology, the lean meat generally needs to be frozen. Before the salt is added to the raw sausage (which is done at the end of cutting/mixing and amounts to approx. 3%) a temperature of approx. -1.5°C is observed in the raw sausage emulsion. After the addition of salt, the freezing point of the lean meat and the temperature drop to a value of approx. -4°C .

The technology

The meat has to be thawed for boiled sausage production. Only in the thawed condition is it possible to swell and break down the meat protein of the lean meat so that it can firmly bind the meat’s own water and the added water and emulsify the fat present.

If the frozen lean meat is thawed properly at temperatures above 0°C and with corresponding air movement, a few disadvantages are encountered:

- Micro-organisms can reproduce quickly during thawing.
- The time taken for thawing is very long.
- Incorrect thawing of the lean meat can greatly impair its technological properties (e.g. water-binding capacity etc.).
- Weight losses result from “drip juice formation” and evaporation.

A further disadvantage of frozen lean meat is that it cannot be processed directly, but instead always has to be thawed first for processing to produce boiled sausage. This costs time and money.

Ingredient	Cutting time in seconds	Knife shaft rpm	Temp. in °C
1. Pre-cut minced bacon fat		3,000	up to 10 °C
2. Remove bacon fat from the cutter			
3. Add frozen lean meat to the cutter	60	1,500	
4. Processing additive on phosphate basis with colour development and flavour enhancer	60	3,000	
5. Add 1/2 the filling, 50 °C Scatter in nitrite salt	60	3,000	
6. Add 1/2 the filling, 50 °C		3,000	up to 0 °C
7. Add pre-chopped bacon fat and seasoning preparation		1,500	up to 10 °C

Fig. 14: Table showing boiled sausage production process with frozen raw meat

In order to rule out these disadvantages the VAN HEES Laboratory developed a technology enabling processors to thaw the frozen raw meat during processing in the cutter. The technology leads to the same and often better sensory results in the finished boiled sausage than is the case with “conventionally thawed” raw meat.

The emulsion temperature course during operations in the cutter with frozen meat is shown in Diagram 13.

Below are the individual processing steps in detail:

1. Pre-cut the bacon fat

The minced bacon fat is reduced in the cutter at knife shaft speeds of 3,000 rpm up to a temperature of 10 °C.

2. Remove bacon fat from the cutter

The bacon fat must be taken from the cutter so that it can be added later, because the mechanical stress during the cutting process is too high. This results in a soft bite.

3. Place frozen lean meat in the cutter

To obtain a large surface area, the lean meat roughly reduced with a frozen meat cutter is further reduced for 60 seconds at a knife shaft speed of 1,500 rpm.

4. Scatter in processing additives on a phosphate basis with colour development and flavour enhancer

Although the meat protein is still frozen at this point and can neither be swollen nor broken down via the processing additive, the processing additive is added already at this stage in order to distribute it optimally.

5. Add 1/2 the filling, 50 °C, scatter in nitrite salt

The first half of the filling is added at a temperature of 50 °C. A higher temperature is not expedient due to the danger of denaturing the meat protein, as this would distinctly reduce the water-binding capacity and the emulsifying capacity.

As a consequence of the intensive reduction of the frozen meat already carried out, there is a very large surface area. The warm water

quickly draws the coldness out of the meat. The meat thaws more quickly.

The common salt in the nitrite salt and the phosphate from the cutter processing agent on a phosphate basis with colour development and flavour enhancer swells or breaks down the available meat protein that has already thawed (see also Section 6.1 "Cutting and mixing with the cutter processing agents phosphate, citrate, acetate and lactate").

6. Add 1/2 the filling, 50 °C

After a further 60 seconds the second half of the filling is added, also at a temperature of 50 °C.

From this time onwards the cutting operation is carried out at knife shaft speed of 3,000 rpm until an emulsion temperature of 0 °C is reached. At 0 °C it is ensured that the entire frozen lean meat is "thawed". Only completely thawed meat protein can be swollen by the common salt (from the nitrite salt) and broken down by the cutter processing agent on a phosphate basis with colour development and flavour enhancer. The better and more intensively the meat protein is swollen and broken down, the better the water-binding capacity and the emulsifying power of the meat protein and the lower the risk of gel and/or fat separation (see also Section 6.1 "Cutting and mixing with the cutter processing agents phosphate, citrate, acetate and lactate" and Chapter 7 "A model consideration of the influences of cutting and mixing on the various quality features of the boiled sausage").

7. Scatter in seasoning preparation, add pre-reduced bacon fat

As in conventional processing, the seasoning preparation is now added. The time margin up to completion of the emulsion is sufficient to distribute the seasonings uniformly.

Through the pre-cutting in the cutter, the bacon fat is available in a form enabling it to be immediately distributed well in the emulsion and emulsified by the swollen or broken down meat protein. The time from adding (0 °C) to the end of emulsion production (10 °C) is perfectly sufficient to distribute and emulsify the pre-chopped bacon fat uniformly in the emulsion.

If the bacon fat only enters the emulsion minced and without having been pre-reduced in the cutter, the time available from the addition (0 °C) to the end of the cutter operation (10 °C) is not sufficient to reduce, distribute and emulsify the only minced bacon fat sufficiently. Coarse visible fat particles and possibly fat separation in the finished sausage are the result.

Adding the minced bacon fat earlier means that it is admittedly 1. very well distributed, and 2. reduced, but the still frozen, not yet swollen or broken down meat protein cannot emulsify it. Furthermore, the mechanical stress resulting from the long running time is very high for the bacon fat, resulting in a softer bite of the boiled sausage.

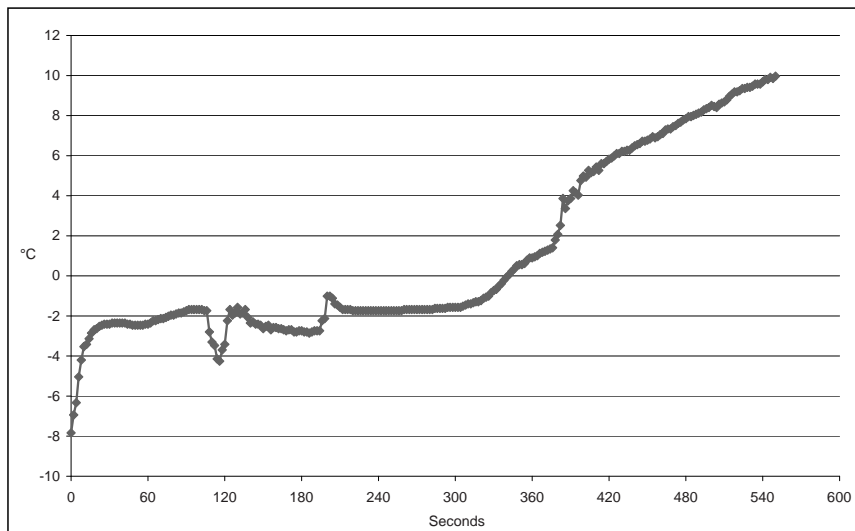


Diagram 13: Temperature course during operations in the cutter for boiled sausage with frozen lean meat

Neither gel nor fat separation could be ascertained in the finished boiled sausage produced in accordance with the method described.

If a sensory test of boiled sausage produced with this technology leads to an excessively firm bite, this can be amended by greater mechanical action in the emulsion during operations in the cutter. For this purpose the temperature of either the whole or only one part of the filling is lowered from 50 °C to 10 °C. This extends the total cutter period distinctly, resulting in greater mechanical action. This in turn leads to a softer bite of the boiled sausage (see also Section 4.3 “The influence of the knife shaft speed (rpm) during operations in the cutter”).

The advantages of this technology are:

- No microbiological stress resulting from the “thawing” of the frozen meat. The thawing operation takes place directly in the cutter during reducing. Micro-organisms have no opportunity to reproduce intensively because of the short thawing period.
- The frozen raw meat is available for production at any time. Production orders received at short notice do not fail because it is not possible to procure meat to be processed in time.
- This technology does not generate any drip juice losses. This increases the cost-effectiveness substantially.
- The process saves time because there is no need for a separate thawing operation of the meat to be processed.

Naturally in this technology too, all other production aspects necessary for successful boiled sausage production, such as the pH value etc. must be observed.

4.8 Cutting and mixing of low-fat boiled sausage in the cutter

For a wide variety of reasons consumers are calling for ever leaner boiled sausages, extending as far as fat-reduced (low-fat) products.

Legal situation

In Germany the “Nutrient Value Labelling Regulation” regulates the conditions to be satisfied by a boiled sausage in order for it to be considered “fat-reduced”. The respective version of the regulation valid at the time must be observed.

To be brought into circulation as fat-reduced boiled sausage, the fat content of a boiled sausage must be at least 30% lower than that of a comparable conventional boiled sausage, whereby the foreign water content of the conventional boiled sausage may not be exceeded in the fat-reduced boiled sausage either. The same rules as for normal boiled sausages also apply for the use of processing additives in fat-reduced boiled sausage.

There are no uniform boundary values for the fat content of boiled sausages in Germany. They are specified differently in the various regions. Information on this is available from the local guilds/chambers or the responsible food surveillance offices.

Design of formulation

In meat products the ratio of water and fat content is very closely connected. For example, if in a formulation consisting of

beef R 3	20%
pork S 3	30%
bacon fat	30%
ice (filling)	20%

only the bacon fat component is reduced, the proportion of foreign water in the finished boiled sausage rises immediately. That is why the fat must be replaced by lean meat. The filling volume must also be adjusted.

After the above formulation has been adjusted to the conditions for fat-reduced boiled sausage, the figures are as follows:

beef R 3	20%
pork S 3	42%
cheeks	20%
ice (filling)	18%

The chemical analysis of this sausage shows the values:

water	67.3%
fat	15.7%
meat protein	15.1%
meat protein free of connective tissue protein (BEFFE)	13.0%
BEFFE in the meat protein	85.9%

The adapted formulation contains a much higher lean meat component and much lower fat component than the initial formulation. The filling too is 2% lower than in the initial formulation.

In this way it is possible to reduce the fat content in the ready-boiled sausage to the measure corresponding to the ruling specified for fat-reduced boiled sausages in the “Nutrient Value Labelling Regulation”.

Sensory aspects

As a result of the high lean meat component in the model formulation of 62% and the low level of filling, the conventionally produced boiled sausage has a very firm to rubbery bite. Consumers are often unwilling to accept this.

Technology

In conventional production of a fat-reduced boiled sausage in the cutter, the time in the cutter is too short and the mechanical stress to which the emulsion is exposed is insufficient to be able to loosen the firm structure that has resulted from the high lean meat component.

Using liquid nitrogen makes it possible to extend the time in the cutter as required at a constant emulsion temperature (see also Section 4.9 “Cutting with liquid nitrogen”). The mechanical stress rises as a result of the long time in the cutter. The bite of the boiled sausage becomes correspondingly softer. It can thus be adapted to customer requirements. If no cutter with a nitrogen facility is available, as is the case in many small craft enterprises, it is necessary to seek alternatives.

In Section 4.7 “Cutting and mixing in the cutter with frozen lean meat”, the problem is totally reversed. As a result of spending too long in the cutter with the associated strong mechanical stress, the bite of the boiled sausage was too soft. By contrast, in the case of the fat-reduced boiled sausage a softer bite is needed. Experience of using frozen lean meat in the cutter has led to the development of the fat-reduced boiled sausages:

- Freeze lean meat.
- Pre-reduce frozen lean meat with the frozen meat cutter.
- Place all the lean meat in the cutter.
- Reduce 30 seconds at a knife shaft speed of 1,500 rpm.
- Add cutter processing agent on a phosphate basis with colour development and flavour enhancer.
- Add ice.
- Scatter in nitrite salt.
- Cut at a knife shaft speed of 3,000 rpm up to a temperature of 0 °C.
- Add minced cheeks and seasoning preparation for boiled sausage.
- Process in the cutter at a knife shaft speed of 3,000 rpm up to 10 °C.