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FREEZE STORAGE OF MEAT AT DIFFERENT TEMPERATURES

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Among the most important factors pertaining to the freezing preservation of meat and other foods are the conditions of freezing (fast or slow freezing) and the temperature during freeze storage. In addition, the quality of the goods to be frozen, e.g. their content of fat, and the size of the items as well as the wrapping material, if used, must be regarded.

It is not possible to give a general recommendation, which would be applicable to any variation of the factors mentioned, and which would also fulfil economical requirements.

In order to solve part of the problems, we started some experiments on beef and pork to get answers, if possible, to the following questions:

1. What temperature ought to be chosen for freeze storage?
2. For how long a period is it possible to store frozen meat without noticeable loss of quality?
3. How do fat and size of the items effect quality and shrinkage during freeze storage?
4. What protection will be obtained by glazing or by using different kinds of wrapping material?

For the experiments wholesale cuts of heifer's rib roasts (with bones) of a weight of 6 - 9 kilos, sliced heifer's rib roasts of a weight of 0.7 - 1.0 kilo of each slice, wholesale cuts of pork loins (with bones but without rind and back fat except a layer of 1 - 3 mm) of a weight of 2 - 2,5 kilos, and sliced pork loins (= pork chops) of a weight of 120 - 170 g of each chop, were used. The carcasses were stored in a cooling room for 3 and 2 days, respectively, before cutting. On account of the nature of the experiments (see below) it was necessary to make use of the meat from many carcasses. These were from animals, which, as far as possible, had the same age, quality, characteristics and antecedents within the respective species.

The items were stored partly unwrapped, partly glazed after freezing and, in the case of slices, also stored after having been wrapped in thick aluminium foil and Cry-o-vac bags respectively. The slices were wrapped before freezing. The Cry-o-vac bags were evacuated and shrunk by dipping in hot water.

It is generally found, that fast freezing will cause less drip after thawing than slow freezing. On the other hand, slow freezing will cause a more tender and juicy meat than fast freezing as stated by Callow (1955).

Freezing was performed in an air blast tunnel at a temperature of -45°C over night (10 hours). The items were then (after glazing in some cases, see above) stored in four top-opening refrigerators without air circulation. The temperature in the respective refrigerator and the storage periods were as follows:-

- 8°C ; 1/4, 1/2, and 1 year
- 15°C ; " " " " "
- 22°C ; " " " " "
- 30°C ; " " " " "

Results on wholesale cuts of rib roasts and pork loins

Unwrapped meat

Serious discoloration, freeze burn and rancidification of the fat in the external parts of all items stored at -8°C and -15°C, less pronounced such damages on samples stored at -22°C for 1/4 and 1/2 year, and just slightly visible deterioration of the items stored at -30°C were observed.

The shrinkage decreased considerably by lowering the temperature. On an average a shrinkage of about 1% and 7% at -30°C and -8°C, respectively, was obtained on the rib roasts after storage 1 year. The corresponding figures for the pork loins were 3% and 10%, respectively.

Glazed meat.

Glazing was shown in some cases to protect the frozen meat against the damages mentioned to an appreciable degree. Yet the items stored for 1/2 and 1 year at -8°C and -15°C exhibited discoloration, freeze burn and rancidification (particularly the pork loins) to nearly the same extent as those, which were not glazed. This may, however, be due to a faster sublimation of the ice than at the lower temperatures. The results on the samples stored at -22°C were intermediate to those obtained at the two higher temperatures and -30°C. The ice layer of the items stored at -30°C had sublimated after about 1/2 year. Thus, some time before the end of this period the meat ought to be reglazed. This was, however, not done in these experiments. By glazing the rib roasts gained 1½ - 2½% in weight, the pork loins 2-4%. After storage for 1 year at -30°C and -8°C the shrinkage was on an average 2½% and 5%, respectively (rib roasts), and 2½% and 8% respectively (pork loins).

Palatability tests.

The meat was thawed, fried in slices and judged by a taste panel. On the outer parts of the meat a rancid taste was established in the same cases as those mentioned above. In some cases the rancidity was very pronounced. The inner parts of the meat were, however, quite perfect even after storage at a temperature of -8°C and for a period of 1 year.

No decision could be made with regard to the correlation between tenderness and storage temperature. Low temperature possibly caused a slight tendency to induce a more tender meat than did higher temperatures.

Drip during thawing

When the storage periods had elapsed, cubes of 150-200 g (without fatty tissue) were sawn out from the internal part of the frozen meat, placed in cans and covered with petroleum ether. In this way the meat cubes were allowed to thaw overnight (15 hours) at room temperature. The drip thus separated was measured. This method of determining the drip has been developed and successfully employed by Kaloyereas (1947). A drip ranging between about 4 and 10% was obtained. No significant difference of drip seemed to

exist between items stored at different temperatures or for different durations. In fact, even duplicates generally agreed poorly, so that the method seems to lack in reproducibility. According to Callow (1955) the way of sawing out the meat cubes, especially the angle between the saw blade and the meat fibres, has been shown to interfere very much with the percentage of drip.

Results on sliced items

Unwrapped and glazed

Similar results as on the corresponding wholesale cuts of rib roasts and pork loins were obtained, yet still more pronounced deterioration and greater shrinkage was noted.

Wrapped in aluminium foil

This material was very efficient against drying and discoloration but could not prevent the fat from getting rancid.

Wrapped in Cry-o-vac, evacuated and heat sealed

This method offered an excellent protection against drying, discoloration, and, at low temperatures, also against rancidification. Practically no shrinage was observed, although the packages were small. The samples stored at -8°C and -15°C for 1/2 and 1 year were significantly rancid.

Discussion and conclusions

The following tables give a summary of the results obtained on wholesale cuts of rib roasts and pork loins:-

Approximate limits for appearance of distinct rancidity of the fat or discoloration of the meat:

Pork loins without rind and most of the back fat removed (unwrapped)

-15°C	-22°C	-30°C
1/4 year	1/2 year	1 year

Rib roasts (unwrapped)

- 8°C	-15°C	-22°C
1/4 year	1/2 year	1 year

By these investigations the importance of a low storage temperature has been evident, particularly when the meat is stored for long periods. When storing wholesale cuts of pork for 1/2 - 1 year there are strong arguments for applying so low a temperature as -30°C. Glazing, if not being considered as fraud owing to adding of ice to the weight of the meat, will retard freeze burn, discoloration and rancidity to an extent sufficiently great for being justified to use even for meat as in the case with fat fish. Yet the ice layer ought to be rather thick and, in addition, reglazing is necessary when the meat is stored for long periods.

Small pieces of meat, e.g. slices, should be wrapped in a vapour and air tight film before freezing. The freeze storage temperature ought to be low, preferably -30°C, especially for storage periods exceeding about 1/2 year.

What has thus been said is valid only for meat in a fresh and good condition before freezing. In particular, the diet will considerably effect the quality and keepability of pork (Dahl, 1957, 1958). In experiments on the keeping qualities of frozen pork Wismer-Pedersen (1957) found that the diet was of a decisive importance for the keepability of different cuts of pork as well as of sausage manufactured from the pork. Thus, pork from pigs fed garbage developed a very bad taste after storage for ½ year at -20°C as compared with pork from pigs fed skim milk and barley, which was palatable even after storage at -20°C for about 1 year. The freeze storage temperature was of a lesser importance than the diet.

For a long time -18°C (=0°F) was considered as a sufficiently low temperature for meat and many other foods. This temperature and even a little higher may be suitable for whole or half carcasses of pigs with rind or quarters of beef, when the storage period does not exceed some months. Later on, the temperature in the cold stores has gradually been lowered to -20°C and -25°C, thus enabling the storage of food for longer periods without deterioration. According to my opinion storage temperatures of about -30°C are, however, so far not applied in practice.

This work has been performed by Helsingborgs Frys, Hälsingborg, and Scan, Malmö, in co-operation.

References

Callow, E.H., 1955. Meat - Scientific Considerations. Comptes Rendus de IXe Congrès International du Froid (Paris, 1955), Tome II,4,119.

Callow, E.H., 1955. Private communication.

Dahl, O., 1957. Einfluss der Fütterung auf Geschmack, Festigkeit und Haltbarkeit von Schweinefett. Fischmehl und Speiseabfälle im Vergleich mit Magermilch. Die Fleischwirtschaft 9, 331 - 333, 336.

Dahl, O., 1958. Influence of the Basal Diet on the Quality of Pig Fat, I. Acta Agriculturae Scandinavica 8, 106-116.

Kaloyereas, S.A., 1947. Drip as a Constant for Quality Control of Frozen Foods. Food Research, 12, 419-428.

Wismer-Pedersen, J, 1957. Nogle iakttagelser ved holdbarhedsforsøg med frosset svinekod. Kulde 11, 54-58 and 72-74.