

The influence of freezing and thawing on the quality of pork

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INTRODUCTION

Pig slaughtering in Sweden is submitted to large seasonal variations which is very inconvenient especially for the cutting-up departments. A constant supply of carcasses is necessary for rational and economic production.

A convenient method to deal with the problem would be to freeze the surplus of carcasses which would then be thawed and cut up during periods of shortage of fresh carcasses. But this could also mean that part of the retailed cuts had to be frozen again, a procedure which at the moment is thought to have negative effects on the meat quality.

This investigation was carried out in order to study the effect of freezing and repeated freezing, thawing and freezing of pork where the following are concerned: weight loss, colour, water binding capacity, weight loss during frying and palatability of the fried meat.

EXPERIMENT

The freezing and thawing experiments were carried out at Scan's cold store in Kävlinge. A number of carcasses were frozen at -40° in a freezing tunnel 24 hours after slaughter. They were kept at -30° . After one, two and three monthly intervals 5–8 carcasses were thawed in a tunnel at $16-18^{\circ}$ for 15 hours and then at 4° for 4–6 hours.

The carcasses were cut into ham, loin, chuck, belly etc. and packed in plastic bags. After storing at about 10° for 2, 8 and 20 hours they were frozen again and stored at -15° , -30° and -50° . Fresh carcasses were treated in the same way.

After three weeks the meat was thawed again and cut up into smaller portions as for the consumer.

The following measurements and judgements were made.

Weight loss was determined at different stages in the experiments.

Colour and appearance were judged by ocular inspection. In one experi-

ment the colour of loin chops was measured by an Zeiss Elrepho remission photometer at 543 mm.

Water binding capacity was determined by the press method of GRAU and HAMM.

Frying losses were determined in loin chops fried in a thermostatically regulated frying pan after frying at 180° for 5 minutes on each side.

Palatability of fried loin chops was judged by an expert panel of 27 members.

The values obtained by the different measurements and judgements were compared with values from fresh meat.

RESULTS

Weight loss

It is wellknown that storing whole carcasses results in a weight loss of about 0,1 % per month due to evaporation from the surfaces. Larger losses occur during the freezing and thawing procedures. In our experiments we found that the carcasses lost an average of 1,6 % in this way. The figures for the individual carcasses varied from 0,9 % to 2,2 %.

Losses due to dripping occurred in the cut-up parts. The amount of drip varied from part to part. In a preliminary experiment it was found that the loin chop had the largest loss and that ham and belly had low losses. Therefore only the drip losses from loin chops were further investigated. The loss due to drip varied from 3,5 % to 8 % in different loins.

The amount of drip did not vary with the storage time of the whole carcasses. Neither did it vary after re-freezing if the cut-up parts were stored at —15°, —30° or —50° for three weeks.

Re-freezing did not increase the amount of drip to more than that obtained by freezing once only but the drip of the frozen meat was much more than that obtained when fresh meat was cut up. The fresh parts lost only about 1,5 %.

Colour and appearance

One of the arguments used by marketing people against frozen meat is the opinion that the colour and appearance of the meat are impaired. It is obvious that the rind will become a little dry and tough as a result of evaporation from the surface, but at least part of the moisture was reabsorbed if the carcasses were kept for 24 hours in a cold room at high humidity.

To form an idea of changes in the colour of the muscle tissues the red colour of loin chops was measured in an Elrepho remission photometer (Table 1). Four samples were measured, the values are the average of six measure-

Table 1. *Colour of loin chops expressed as percent remission at 543 nm.*

Sample	Remission %		
	fresh	frozen	refrozen
1	11.2	11.9	18.0
2	15.3	17.6	7.2
3	16.0	16.4	14.5
4	13.1	20.4	12.4

ments. The results were expressed in percentage of remission, a low value means a darker colour than a high one.

As can be seen from the table there were not any differences in colour between the three types of loin chops.

Ocular inspection of several hundred loin chops revealed very large individual variations in the meat colour. The variations within each group were so large that it was meaningless to try to distinguish between the groups on account of the colour.

On the meat side of the belly spots of weak freeze burn were detected in a few cases, but they disappeared in nearly every case after storage for 24 hours in a cold room. No freeze burns were observed on meat that had been frozen once only. There was a slight tendency of this fault to increase with increasing storage time of the whole carcasses.

In other parts no colour changes were observed.

Water binding capacity

One experiment was performed at the time when the carcasses had been stored at -30° for one month. The results are shown in table 2 which also gives the water content of the samples. The water binding capacity is expressed

Table 2. *Waterbinding capacity and water content of fresh, frozen and twice frozen meat*

Sample	Bound water			Water content %		
	fresh	frozen	refrozen	fresh	frozen	refrozen
1	37,3	42,6	40,7	73,9	74,9	73,1
2	35,7	46,1	51,1	73,5	72,5	75,1
3	38,7	44,7	42,0	75,1	72,3	73,0
4	34,8	44,7	62,8	73,7	72,2	71,9

sed in percentage of the water firmly bound. The higher the value the better the water binding capacity. As can be seen from the table, freezing and refreezing did not negatively influence the water binding capacity.

The water content of the three types of meat was approximately the same which may seem astonishing on account of the drip losses of the frozen meat. But the drip contains not only water but also solid components. Therefore the relative water loss will not be as high as expected.

Frying losses

These experiments were carried out at times when the whole carcasses had been stored for two and three months respectively before cutting up into ham, loin, etc. Two more factors varied, the time between cutting up and freezing, 2 hours and 24 hours respectively and the time between thawing and frying, 4–6 hours and 24 hours respectively. The individual variations in the frying losses were large, so large that the differences in the mean values between fresh, once, and twice frozen loin chops were insignificant (table 3). It is also obvious that the storage time of the carcasses was not important in this respect, neither were the losses influenced by the length of time the cut parts were kept before freezing or re-freezing.

Table 3. *Frying losses of loin chops. Comparison between fresh, frozen and refrozen chops.*

	Weight loss %					Fresh			
	Refrozen after		Frozen after						
	2 h	24 h	2 h	24 h					
Carcasses stored for two months	22,9	24,3	26,9	30,7	22,4	Fried	2 h after thawing		
	31,2	29,6	30,7	33,2	32,9	Fried	24 h after thawing		
Carcasses stored for three months	29,1	28,1	27,2	27,2	31,0	»	»	»	

But the time when the frying took place was important. If the meat was fried directly after thawing instead of after only a few hours, the losses increased significantly.

The freeze storage temperature of the cut parts did not influence the losses in the temperature range from -15° to -50° .

Palatability

The palatability was investigated by testing refrozen loin chops, as opposed to fresh and frozen chops and testing frozen chops as opposed to fresh

chops in a series of triangle tests. The panel was composed of 27 expert members. The results are summarized below.

Carcasses stored at -30° for 2 months

75 %	of the panel	preferred	refrozen	meat	before	fresh	meat
67 %	»	»	»	»	»	»	frozen meat
60 %	»	»	»	»	fresh	»	»

Carcasses stored at -30° for 3 months

70 %	of the panel	preferred	refrozen	meat	before	fresh	meat
70 %	»	»	»	»	frozen	»	»
70 %	»	»	»	»	»	»	refrozen

The conclusion of these test results was that it was impossible or very difficult even for an expert to distinguish between the three types of meat.

DISCUSSION

Freezing, thawing and refreezing may cause *some* changes in some qualities of the pork, i.e. weight losses due to evaporation and drip, colour changes, impaired water binding capacity, increased cooking losses and changes in palatability. There may also be problems relating to bacterial growth on the meat.

It is obvious that some weight losses cannot be avoided. The problem is mainly an economical one but as the drip contains minerals, vitamins and some protein there is also a small decrease in the nutritional value.

Regarding the colour changes it is often heard that re-freezing results in darkening, especially of the cut bone surfaces. In our experiments, with freezing and thawing performed under strict conditions, no such discolouration was found. But in samples taken from several commercial cold stores this phenomenon was found regularly. This stresses the importance of correct procedures.

The water binding capacity is a very important quality in the case of meat intended for sausage production. Table 2 shows clearly that this property was not impaired by the freezing and thawing processes. Neither was the suitability of the meat for direct consumption diminished as it was found that the cooking losses and the palatability, two qualities important to the consumers, were the same in fresh, frozen and refrozen meat.

The bacteriological problems of frozen meat may also be of importance. Principally the freezing ought to have a deteriorating effect at least on some types of bacteria. But thawing under unsuitable conditions may lead to a

considerable increase in the surface flora. We are at the moment working on the problem.

REFERENCES

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