Technological properties of frozen and refrozen meat

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INTRODUCTION

Freezing of whole carcasses is a necessity in many slaughterhouses due to large seasonal variations in the supply of animals. Such carcasses are later thawed before further processing into retail cuts and cuts/trimmings for sausage production.
Although some research has been done on the effect of refreezing (Nilsson, 1969; Danchev and Lalov, 1977), it is still debated whether meat for processing can be refrozen without appreciable adverse effects on its technological properties.

Dyer *et al.* (1962) concluded from studies on fish fillets that refreezing *per se* did not affect the quality of the fillets. On storage of the refrozen fillets, however, large decreases in the taste panel scores resulted, indicating a reduced storage stability of the refrozen fish meat. The results of our present work on refrozen beef parallel the observations made by Dyer and coworkers. There seems to be no reason for concern regarding refreezing, provided the storage time after refreezing is short. The results call for caution, however, with regard to long-term storage of refrozen meat.

MATERIALS AND METHODS

Experiment 1

Beef with 15% fat and pork backfat with about 90% fat were bought fresh (unfrozen). The fat tissue was cut into pieces of about 3x3x3 cm which were mixed and then stored at 2-4°C. The unfrozen meat was similarly cut and mixed, and weighed into 3.0 kg batches in plastic bags. The batches were cooled, frozen and thawed according to the time schedule shown in Table 1.

The water holding capacity (WHC) of fresh, frozen and refrozen meat was determined by centrifugation: Meat batches were ground once through a 3 mm grinder plate. Samples of 40 g were centrifuged at 15 000 xg for 10 min at 20°C in 50 ml centrifuge tubes. Per cent liquid released was calculated after decanting and weighing.

The sausage recipe is presented in Table 2. Chopping was performed in a 10 l bowl chopper following a strictly standardized procedure. After stuffing in 36 mm edible collagen casings the emulsions were cooked to a centre temperature of 76°C. Cooking losses were determined. The sausages were then stored at 2-4°C prior to characterization.

Table 1. Time schedule of Experiment 1.

	Meat sample I (fresh)	Meat sample II (frozen)	Meat sample III (refrozen)
Day 1	cooled to +4°C	frozen at ÷20°C	frozen at ÷20°C
Day 2	+4°C contd.	÷20°C contd.	thawed completely and refrozen at ÷20°C
Day 3	WHC by centrifugation, sausage production	thawed at +4°C	thawed at +4°C
Day 4		+4°C contd.	+4°C contd.
Day 5		WHC by centrifugation, sausage production	WHC by centrifugation, sausage production

Table 2. Formulation for sausage manufacture.

Beef, 15% fat	3000 g
Pork backfat	665 g
Water/ice (50/50)	870 g
Salt	83 g
Pepper	3 g
Ginger	3 g

Sausage texture (hardness, chewiness, juiciness and oiliness) was evaluated by a trained laboratory taste panel of 12 persons. Serving temperature was about 50°C. The hardness of sausages made of frozen and refrozen meat was also compared by measurements on an Instron Universal Testing Machine equipped with a pointed probe according to the method described by Andersson and Hansson (1979).

periment 2.
esh beef was cut, mixed and packed as in Experiment 1. Six batches (II and III) for saus-
e production were frozen at ÷20°C. Three frozen batches were thawed completely on the
llowing day and refrozen at ÷20°C (III). After storage at ÷20°C for 3 months all samples
re thawed at +4°C. Sausages were then produced as in Experiment 1.
esh pork backfat was used.
e to a breakdown of the bowl chopper used in Experiment 1, the sausages in Experiment 2
re produced using a lab-scale chopper followed by emulsification in a Stephan Microcut.
s caused the sausages obtained to be of lower quality than in Experiment 1. The sausages
re evaluated by sensory and instrumental testing as in Experiment 1.

SULTS AND DISCUSSION

periment 1 was designed to examine eventual effects of freezing and refreezing *per se* on
e technological properties of the meat. The aim of Experiment 2 was to evaluate possible
ng-term effects of refreezing due to reduced storage stability after freezing, thawing and
freezing of the meat.

e results of Table 4 and 5 show that freezing or refreezing *per se* of the meat raw materi-
(Exp. 1) did not influence the quality of the cooked sausages: No differences were found
texture characteristics of the sausages in spite of a significant decrease in the water
lding capacity of the meat (Table 3).

e results further show that sausages made of meat stored for 3 months (Exp. 2) after freez-
g or refreezing could be distinguished by the reduced juiciness of the sausages made of
frozen meat compared to of ordinary frozen meat. The results of the instrumental texture
asurements are not conclusive due to the high standard error of the measurements.

Table 3. Water release from ground meat samples upon centrifugation as affected by freezing and thawing

	Sample I (fresh meat)	Sample II (frozen)	Sample III (refrozen)
% water released	6.4 ± 0.4*	8.2 ± 0.4	13.0 ± 0.5

* mean ± S.E. of four centrifugations.

ble 4. Effect of freezing/refreezing/thawing of the meat indredient on sausage texture; sensory evaluations.

	Experiment 1 Freezing/thawing without storage			Experiment 2 Freezing followed by 3 months of storage	
	I	II	III	II	III
rdness (initial)	4.1 ± 0.1*	4.1 ± 0.1	4.1 ± 0.1	4.3 ± 0.1	4.2 ± 0.1
ewiness (chewing resistance)	4.1 ± 0.1	3.9 ± 0.1	4.0 ± 0.1	4.5 ± 0.2	4.3 ± 0.1
iciness (during chewing)	5.0 ± 0.1	5.0 ± 0.1	4.9 ± 0.1	4.1 ± 0.1[a]	3.6 ± 0.1[a]
iness (during chewing)	4.5 ± 0.1	4.2 ± 0.1	4.2 ± 0.1	4.3 ± 0.1	4.0 ± 0.1

ean ± S.E. of three different productions. Each production evaluated by a 12 member labo-
tory panel.
umeric values of Exp. 1 and Exp. 2 not to be compared.
-sausages made of fresh meat; II-made of frozen meat; III-made of refrozen meat.

Table 5. Hardness of sausages as measured by an Instron method (penetration with pointed probe).

	Experiment 1		Experiment 2	
	II	III	II	III
Hardness, g	443 ± 23*	395 ± 17	419 ± 26	365 ± 12

* mean ± S.E. of three different productions. Each production evaluated by 5 measurements.
II-sausages made of frozen meat; III-made of refrozen meat.

In preliminary measurements we have found higher peroxide values and thiobarbituric acid values in the refrozen meat than in the ordinary frozen meat after three months of frozen storage. It is possible that refrozen meat is more prone towards autoxidation, and that primary or secondary products of lipid oxidation influence the technological properties of the meat by interaction with the muscle proteins (i.e. myosin). This possibility is under investigation in our laboratory.

REFERENCES

Andersson, L. and Hansson, K.E. (1979) 25th European Meeting of Meat Research Workers, Budapest, Proceedings, 331

Danchev, St. and Lalov, M. (1977) 23th European Meeting of Meat Research Workers, Moscow, Proceedings

Dyer, W.J., Fraser, D.I., Ellis, D.G., Idler, D.R., MacCallum, W.A. and Laishley, E. (1962) Bul. de l'Institut Intern. du Froid, Annex 1, 515

Nilsson, R. (1969) 15th European Meeting of Meat Research Workers, Helsinki, Proceedings, 492