The effect of meat freezing on the water-binding capacity of cooked sausage

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Introduction

The effect of meat freezing on the water-binding capacity of cooked sausage has not been extensively studied even though the use of frozen meat is very common in the meat industry. Hamm (review 1972) pointed out that the freezing of meat does not have any marked effects on the quality of the meat. However, the drip loss is greater when the water-binding capacity of meat is low before freezing, due either to a low pH-value or some other reason.

When the freezing rate is high, small crystals are formed inside the cells; when it is low, larger crystals are formed. As a result, a low freezing rate easily causes a large drip loss (Anon and Calvelo 1980). This does not necessarily create a larger jelly formation in cooked sausage (Skenderovic and Rankow 1977).

Long freezer storage causes weight loss and a lowering of the water-binding capacity. This is a result of reactions of the reactive groups of proteins (e.g. SH-groups) and, possibly, also of reactions of the oxydation products of lipids, which polymerize proteins (Hamm, review 1972, Miller, review 1980). Gumpen and Fretheim (1981) stated that the freezing of sausage raw materials lowered the water-binding capacity. The effect was even more distinct when the meat was refrozen after thawing. Hamm (1962) noted that drip fluid acts as anions causing an increase in the water-binding capacity of meat when the pH-value is above the isoelectric point.

Materials and methods

Water-binding capacity was determined by making sausages with a kitchen cutter using very high water addition. Sausages were stuffed and cooked according to standard industrial practice (Puolanne et al. 1980).

The formulations were as follows:

	A (No added phosphate)	B (Phosphate added)
lean beef g	60	50
pork g	60	35
water g	100	120
NaCl g	4,5 (2 %)	4,4 (2 %)
polyphosphate	-	0,6 (0,15 % P_2O_5)

Results and Discussions

Effect of drip fluid. When the frozen beef was thawed the amount of drip fluid formed was 6.1 - 7.1 %. The sausages were prepared in (A) by adding the drip fluid back to the meat, and in (B) by leaving it out. The water-binding capacity of the meat was calculated on the basis of the original (frozen) weight. In the sausages with drip fluid the water-binding capacity was significantly better than in the sausages without drip fluid (table 1).

Grinding before freezing. The grinding of lean beef before freezing decreased the water-binding capacity of the meat in the sausages without added phosphate. In the sausages with added phosphate the grinding of the meat increased the water-binding capacity. The drip fluid was added to the meat in all cases (table 2).

Table 1. Water-binding capacity (WBC) of beef in cooked sausages with drip fluid (A) and without drip fluid (B).

	Number of samples		WBC ($g\ H_2O/100\ g$ meat)[1)] A	B
Without added phosphate	12	$\bar{x}$ s	55.0 3.4	51.0[2)] 2.7
With added phosphate	12	$\bar{x}$ s	93.8 4.2	87.8[3)] 4.7

1) frozen weight basis 2) A > B; $p < 0.05$ 3) A > B; $p < 0.001$

Table 2. Water-binding capacity (WBC) of beef in cooked sausages when meat was ground (A) was not ground (B) before freezing.

	Number of samples		WBC ($g\ H_2O/100\ g$ meat) A	B
Without added phosphate	11	$\bar{x}$ s	47.4 3.1	51.7[1)] 5.4
With added phosphate	9	$\bar{x}$ s	91.3 2.1	83.3[2)] 6.0

1) A < B; $p < 0.01$ 2) A > B; $p < 0.01$

Addition of salt by freezing. The lean beef was ground and divided into two parts. Salt was added to one part before freezing (A) and the other was frozen without salt (B). The addition of salt before freezing did not have any significant effect on the water-binding capacity (table 3).

Table 3. Water-binding capacity of meat in cooked sausage when the ground beef was salted (A) or not salted (B) before freezing.

	Number of samples		WBC ($g\ H_2O/100\ g$ meat) A	B
Without added phosphate	6	$\bar{x}$ s	47.9 3.9	44.0[1)] 3.8
With added phosphate	4	$\bar{x}$ s	85.0 2.7	87.8[1)] 2.8

1) differences not significant ($p > 0.05$)

Freezing and thawing rates. Lean ground beef was frozen in plastic bags in 1 cm thick plates. Slow freezing took place in a box in which the meat hardened within 10 - 12 hours. Standard freezing took place on the shelves of a freezer where the meat hardened within 1 hour. Quick freezing was achieved by covering the bags with CO_2-snow. In this case the hardening took place in ca 5 minutes. Storage time of the frozen meat was one week. Slow thawing took place in a box over a 10 hour interval. When thawed at room temperature the thawing time was ca 1 h and 2 - 3 min in a microwave owen.

Without added phosphate the effect of freezing and thawing rates was significant (table 4). Quick freezing was the worst method by a significant amount. Anon and Calvelo (1980) found that a freezing time of 17 min yields the largest drip loss. This may explain the low water-binding capacity of what we've called quick freezing in this study because the freezing time inside the meat may have been approximately 17 min. Thawing at room temperature was significantly the worst method. With added phosphate the differences between freezing methods on the one hand and thawing methods on the other were not significant.

Table 4. Water-binding capacity of meat (g H_2O/100 g meat) in cooked sausage where the lean beef was frozen and thawed using different methods. Number of samples N = 5.

Freezing		Thawing 4 °C/10 h	20 °C/1 h	Microwave 2 - 3 min	$\bar{\bar{x}}$
Without added phosphate[1)]	10 h	46.9	44.5	48.2	46.5
	1 h	46.3	44.4	48.3	46.3
	5 min	44.9	40.9	46.1	44.0
	$\bar{x}$	46.0	43.3	47.6	
With added phosphate[2)]	10 h	86.8	90.0	88.9	87.9
	1 h	88.4	86.0	90.0	88.2
	5 min	88.6	84.0	88.8	87.5
	$\bar{x}$	88.3	86.0	89.3	

1) Differences significant between freezing and thawing methods ($p < 0.01$)

2) Differences not significant ($p > 0.05$).

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