THE EFFECT OF RAPID CHILLING ON PORK QUALITY IN THE NETHERLANDS

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INTRODUCTION

In an effort to reduce weight loss and increase turnover, many pig slaughter plants have introduced rapid chilling procedures. It has been suggested that an added beneficial side effect of rapid chilling would be reduction in the incidence of so-called PSE (Pale, Soft and Exudative) pork (Tarrant, 1989; van Laack and Smulders, 1995).

As the post mortem pH-decline in pigs is relatively fast, the risk of cold shortening, and associated toughening, would be expected to be minimal. Nevertheless, there have been several reports suggesting that rapid (blast) chilling of pork carcasses, negatively impacts the tenderness (Tarrant, 1989; Taylor, 1990; van Laack and Smulders, 1995).

In previous laboratory studies (van Laack and Smulders, 1991), we did not observe any significant effect of chilling on either color, drip loss or tenderness. In those studies, we used pre-rigor excised muscles and it is conceivable that pre-rigor shortening 'masked' a potential effect of chilling rate. To assure that the chilling procedures currently used in The Netherlands do not negatively impact quality, we studied the effect of chilling procedures under commercial processing circumstances on pork quality.

MATERIALS AND METHODS

Experiment 1:

At a commercial slaughter plant, 60 Large White/Landrace crossbred pigs were selected (pH at 45 min post mortem >6.0). At ca. 45 min post mortem (PM), 30 carcasses were chilled rapidly (45 min at -30°C, air velocities of 5 m/s) followed by 18 h at 2 ± 2°C (still air). The remaining 30 carcasses were chilled 19 hr at 2 ± 2°C. At 20 h PM, one (randomly chosen) side of each carcass was deboned. Meat quality characteristics of the *M. longissimus lumborum* were assessed.

Experiment 2:

This experiment was similar to Experiment 1, with the difference that only 16 pigs were used. At 20 h PM, *Mm. longissimus lumborum, semimembranosus* and *triceps brachii* were excised. These muscles were divided in 2 equal parts. One part was analyzed immediately, e.g. 1 day PM, whereas the other part was stored vacuum packaged until 6 days PM and then analyzed.

Methods

The following characteristics were assessed a. ultimate pH, b. Minolta L*-value, c. drip loss during vacuum storage, d. cooking loss % after heating to a core temperature of 70°C in a waterbath of 75°C, e. sarcomere length and f. Warner-Bratzler shear force values of the cooked meat.

Data were analyzed statistically using the Student t-test.

RESULTS AND DISCUSSION

The results of Experiment 1 are included in Table 1. Rapid chilling did not significantly ($p>0.01$) affect any of the measured characteristics. Thus, these results confirmed those obtained in laboratory studies (van Laack and Smulders, 1991).

In experiment 1, tenderness was assessed at 1 day PM, e.g. before ageing. It might be suggested that chilling rate influences tenderness not via an effect on the degree of shortening but via an effect on proteolytic activity, e.g. chilling rate impacts the ageing response or tenderization during storage. In experiment 2, we studied the influence of chilling on tenderness at 1 day PM as well as at 6 day PM.

In most studies, the effect of chilling on the longissimus muscle is assessed. This muscle is chosen because it is easily accessible, and because it is very prone to cold shortening due to its anatomical position. However, the presence or absence of a treatment effect on the longissimus muscle does not guarantee a similar result in other muscles. In the second experiment, we analyzed the semimembranosus and triceps muscle as well. The choice of these muscles was based upon location, type and commercial importance.

Results of experiment 2 are included in Table 2. Again, chilling procedure did not significantly ($p>0.01$) affect color, drip and cooking loss, sarcomere length or shear force. At 1 and 6 days PM, quality of the conventionally-chilled muscles was comparable to quality of the rapidly-chilled muscles.

Results of the present study suggest that rapid chilling cannot be used to reduce the incidence of PSE. However, it should

be realized that the effect of chilling on color and drip loss (or water-holding capacity) is strongly dependent on the rate of pH-decline (Offer, 1991); in slow-glycolyzing muscles, the influence of temperature on color and drip loss will be minimal. The potential benefit of rapid chilling on pork quality (reduced PSE) can only be assessed under PSE-inducing conditions, e.g. in fast-glycolyzing muscles.

With respect to the effect of chilling rate on tenderness, variable results have been reported (see Tarrant, 1989 and van Laack and Smulders, 1995). It is not clear what causes this variation in results. Factors such as carcass weight and rate of pH decline may interact with the effect of chilling. In the present study, post mortem pH-decline was relatively slow. Nevertheless, we did not observe toughening of the rapidly-chilled muscles. Possibly, other factors related to genetics such as ultimate pH and intermuscular fat contact, interact with the effect of chilling on tenderness.

CONCLUSION

Current Dutch circumstances permit the meat industry to take advantage of rapid chilling such as increased turnover and reduced weight loss (in present study 1.8% vs. 2.4% for rapid vs. conventional chilling) without jeopardizing quality. However, as the effects of rapid chilling seem to be dependent on specific conditions, the industry would be well advised to re-evaluate the quality of the product whenever production procedures change.

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Table 1: The effect of rapid (45 min -30°C, 18 h 2±2°C) vs. conventional (2±2°C) chilling on tenderness-related characteristics (1 day post mortem) of porcine *M. longissimus lumborum* (N=30; Experiment 1).

Chilling	Ultimate pH	Cooking loss	Sarcomere length (μm)	Shear force (kg/cm²)
Conventional	5.59±0.15	23.3±3.9	1.78±0.09	5.40±0.82
Rapid	5.67±0.25	23.0±4.7	1.74±0.11	5.53±1.10

Table 2: The effect of rapid (R) vs. conventional (C) chilling on quality characteristics of porcine *M. longissimus lumborum*, *M. semimembranosus*, *M. triceps brachii* (N=16; Experiment 2).

	M. longissimus lumborum		*M. semimembranosus*		*M. triceps brachii*	
	C	R	C	R	C	R
L*-value	53.3±2.7	53.6±2.9	47.7±2.6	48.0±1.2	ND*	ND*
Drip loss %	3.4±1.6	2.7±1.4	4.0±1.6	3.0±1.5	1.8±1.5	1.2±0.7
Cooking loss %						
day 1	17.0±3.8	17.7±4.5	20.9±4.9	16.8±4.7	19.5±5.2	16.6±4.1
day 6	18.3±3.1	19.1±3.9	16.8±4.7	21.7±4.5	17.5±4.0	19.2±3.6
Sarcomere length (μm)	1.71±0.11	1.71±0.13	1.82±0.24	1.84±0.24	2.17±0.13	2.19±0.19
Shear force (kg/cm²)						
day 1	4.8±0.9	4.7±1.2	5.6±0.9	5.4±0.7	4.5±1.0	4.8±0.8
day 6	3.8±0.8	4.0±0.7	4.5±0.8	4.2±0.6	3.7±0.8	3.8±0.6

*ND = Not Determined