CARCASS YIELD, MEAT QUALITY AND FUNCTIONAL PROPERTIES OF PORK AS AFFECTED BY HOT PROCESSING PROCEDURES.

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SUMMARY

Nine experiments, involving a total of 126 Large White/Dutch Landrace cross-bred pigs, were conducted to evaluate the effects of hot boning in processing sequences, including electrical or no stimulation, scalding or skinning, blast-chilling or conventional chilling of carcasses, and high temperature conditioning of vacuum-packaged primals. As compared with cold boning, hot boning generally resulted in markedly less weight loss, similar or higher meat- fat- and bone-yields and, after 12-13 days of vacuum storage, in slightly darker meat with less drip and similar in tenderness. Whereas neither electrical stimulation nor skinning affected meat quality significantly, high temperature conditioning of hot boned, vacuum packaged pork effected lighter, more tender pork with less drip than no conditioning. Major advantages of pre-rigor pork are superior water-binding and fat emulsifying properties. The latter finding is particularly relevant for the processing of low-sodium and low-phosphate products.

INTRODUCTION

Hot boning of pork has traditionally been practiced in (Eastern) Europe for the processing of meat products. Its use for the production of fresh pork is relatively new and few research data are available to analyse the benefits for the pig meat industry. The continuous pressure on the industry to produce high quality products at low costs has led meat scientists in The Netherlands to initiate research on accelerated processing of pork. Purpose of this paper is to evaluate its effect on carcass yield characteristics, on sensory properties of fresh, vacuum packaged meats and on the functional properties of pre-rigor processed pork products.

MATERIALS AND METHODS

The experiments involved a total of 126, well-rested, Large White/Dutch Landrace cross-bred pigs. Pigs were showered in lairage to reduce stress (Smulders et al 1983). At the end of the slaughterline (ca. 20 min post mortem) carcasses were selected on the basis of pH and Fibre Optic Probe values in the loin. Table 1 includes the boning options that were investigated. Electrical stimulation at 15 min post mortem was applied with 300 V, 50 Hz, 1 A, continuously during 30 s. Options A through F included scalding of the carcass at 60°C. Skinning was conducted with a vertical drum skinner. All right hand side primals were hot boned either within 1.5 post mortem [{with the exception of exp. # 1 and 2 in which loins were left on the vertebral attachments); options A,B,E,F and G], or at approximately 3.5 h post mortem (Hermansen 1987; options C and D). Cold boning of the left hand side primals was conducted after overnight storage at 11°C. Hot and cold boned primals were vacuum packaged in a film with low O_2 permeability, in the case of pork loins with inclusion of "Bone-guard" to assure package integrity. After 12-13 days of storage at 11°C the meat was unpacked and the sensory quality traits assessed according to the procedures described by Smulders (1986). Processing of pre-rigor whole muscle or blending of comminuted/salted pork for the production of meat products was done immediately after boning. Unless indicated otherwise, comparisons of hot and cold boning treatment were made between muscles within a carcass.

Table 1 Concepts of hot boning pig carcasses as tested in 9 experiments

Hot boning procedure	Concepts A	B	C	D	E	F	G
Electrical Stimulation					X	X	
Scalding / Singeing	X	X	X	X	X	X	
Skinning							X
Blast Chilling (80 min/-30° C)			X	X			
Equilibration (100 min/1±1° C)			X	X			
Hot boning / Vacuum packaging	X	X	X	X	X	X	X
Conditioning (4h/15°C or 8°C*)		X		X*		X	
Chilled storage at 1±1° C	X	X	X	X	X	X	X

Table 2 Contrasts in carcass yield between hot boned (HB) righthand sides and cold boned (CB) lefthand sides of pig carcasses as assessed by weighing immediately after boning ($\Delta = \bar{x}_{HB} - \bar{x}_{CB}$, as % of warm carcass weight); underlined contrasts are significant (p<.05)

Carcass treatment	exp.#	n	Δ Meat Yield	Δ Fat Yield	Δ Bone Yield	Δ Total Weight Loss
Scalding	1	10	-0.2	0.8	0.2	<u>-1.80</u>
Scalding	2	6	-0.3	1.2	<u>0.6</u>	<u>-2.66</u>
Scalding	4	20	<u>0.7</u>	<u>0.5</u>	-0.2	<u>-1.48</u>
Scalding / Blast-chilling	7	8	0.3	0.0	-0.3	<u>-0.78</u>
Scalding / Blast-chilling	8	8	0.0	0.9	0.5	<u>-0.70</u>
Skinning	9	8	<u>1.2</u>	0.3	0.4	<u>-1.55</u>

Table 3 Contrasts in sensory quality traits; underlined contrasts are significantly different (P< .05)

a. Between hot boned (HB) righthand side- and cold boned (CB, not conditioned) lefthandside pork loins from the same carcass ($\Delta = \bar{x}_{HB} - \bar{x}_{CB}$)

			Assessed at day 0-1		Assessed at day 12-13				
Hot Boning Concept	Exp #	(n)	Δ pH at start boning	Δ T at start boning	Δ Drip (%)	Δ Transm. (%)	Δ Colour (Hunter L)	Δ Sarc.L. (μm)	Δ Shear (N/cm2)
A	1	(10)	0.95	32.2	0.19	n.d.*	-1.05	0.07	5.20
A	2	(8)	0.58	30.9	0.40	n.d.	-0.94	0.06	3.00
A	3	(8)	0.92	37.4	-1.11	-2.80	-0.50	-0.04	1.30
A	4	(20)	1.02	35.6	0.46	0.40	-2.20	-0.02	0.20
A	5	(8)	n.d.	n.d.	-2.52	1.00	-3.20	n.d.	5.50
B	5	(8)	n.d.	n.d.	-2.92	1.00	-2.50	n.d.	3.00
C	6	(8)	0.39	10.0	0.20	n.d.	0.60	-0.01	1.30
C	7	(10)	0.31	9.4	-1.72	0.30	-0.60	0.00	-0.40
D	6	(8)	0.39	10.0	-0.49	n.d.	0.50	0.10	4.00
D	7	(10)	0.18	8.6	-0.35	0.00	-1.20	-0.07	-1.90
D	8	(8)	0.24	11.3	-0.74	n.d.	-1.40	0.04	1.30
E	5	(8)	n.d.	n.d.	-1.67	-3.00	-3.30	n.d.	10.80
F	5	(8)	n.d.	n.d.	-2.31	-5.00	-2.50	n.d.	7.00
G	3	(8)	1.27	37.1	-0.54	-3.40	1.00	-0.01	-1.60
b. Between conditioned and not conditioned, hot boned pork loins from different carcasses									
F	5	(8)	n.d.	n.d.	-0.51	-2.00	-0.80	n.d.	-0.31

* n.d. = not determined

RESULTS AND DISCUSSION

Table 2 includes the effects of hot vs. cold boning on yield characteristics of pig carcasses as determined in 6 experiments involving a total of 60 pigs. Generally the percentage meat yield was similar for hot and cold boning. In the first experiments (# 1 and 2), where boners were unfamiliar with hot boning, meat addles were slightly lower (P<0.05). Later experiments (e.g. # 4 and 9) revealed significantly higher meat yields (P<0.05). The fact that fat yields were consistently, in one experiment significantly, higher when the meat was hot boned, indicates that higher meat addles do not result from differences in trimmed-off fat but probably from differences in evaporative weight loss. Total evaporative weight losses were significantly, up to 3.5%, lower after hot boning. The range in the total weight loss contrasts may be explained by the time of boning, differences in water uptake, and evaporation during scalding and chilling. Water taken up during scalding has largely been evaporated by the time boning is started. this does not apply to skinning. Yet it appears from the figures of that experiment that at least 1.5% less weight loss may be expected and that a considerable part is represented in an increased meat yield. Our observations on weight losses after approximately 2 weeks of storage, further suggest that this advantage is not lost as drip in vacuum. Both packer and wholesaler may therefore benefit from this. More research is necessary to establish if the advantages are not partly lost in the course of cutting up primals to chops for retail purposes. Recent experiments by van Laack and Smulders (unpublished), where drip loss of vacuum packaged whole pork loins are compared with water holding capacity tests as devised by Honikel (1987), suggest that this may be the case.

Table 3 includes the contrasts in sensory quality traits between hot boned and cold boned (not conditioned) pork loins. It is evidence that, when hot boning is postponed until 3.5 h post mortem (concepts C and D, experiments 6 through 8), the pH at the start of boning is considerably lower than when boning is started immediately after slaughter. Thus potential pre-rigor advantages in terms of sensory and functional properties may also be reduced. We already discussed the lower percentages of drip loss in vacuum of hot boned cuts. Occasionally these differences in drip were associated with lower transmission values, which indicate differences in degree of sarcoplasmic protein denaturation (Hart 1962). Through this mechanism the contrasts in water-holding capacity might be explained. Possibly, differences in protein denaturation may also be responsible for the darker colour (high Hunter L values) of hot boned loins. Sarcomere lengths, reported to influence water-holding capacity (Honikel et al., 1986), were similar for hot and cold boned loins in most cases where drip percentaged differed. Therefore, it is unlikely that the degree of muscle contraction was a significant factor in drip formation. Shear forces were similar but in three experiments slightly higher. We do not expect such small differences to be of practical significance to the consumer.

Table 4 includes the functional properties of pre-rigor vs. post-rigor pork, as illustrated by several popular pork products. In some countries the use of phosphates in meat processing is limited or even prohibited. In these

Table 4 Functional properties of pre-rigor and post-rigor pork as illustrated by cured(cu), comminuted(co), salted(sa), cooked(ck) and smoked(sm) products, processed with or without phospates

Product	Functional property	With phosphates		Without phosphates	
		Pre-rigor	Post-rigor	Pre-rigor	Post-rigor
Bacon (cu)	% weight gained (cu)	n.d.*	n.d.	14.9	12.5
	% weight drained	n.d.	n.d.	3.0	1.1
Ham ;fast glycolysis (cu/ck)	pH/start processing	n.d.	n.d.	6.3b**	5.8a
	% cooking loss	n.d.	n.d.	19.1c	21.8a
;slow glycolysis	pH/start processing	n.d.	n.d.	6.6a	5.9c
	% cooking loss	n.d.	n.d.	17.7b	19.8c
Luncheon meat at F_0=1 (co/sa/ck)	mm penetrometer	96.9	96.2	97.1	95.1
at F_0=3	mm penetrometer	106.6b	122.0a	120.5a	127.8c
at F_0=1	% water exudation	2.1b	2.6c	1.9a	3.1d
at F_0=3	% water exudation	2.7c	3.0c	3.0c	3.9d
Sausage 42% pork (co/sa/ck/sm)	% w. fat separation	0.0	0.0	36.0b	82.0c
25% pork	% w. fat separation	16.0a	38.0b	65.0c	100.0d

* n.d.= not determined
** means with different superscripts differ significantly (P<.05)

countries pre-rigor processing of pork is traditional or is advocated as an attractive alternative. Major advantages of hot processing of pork, claimed by the scientific literature (Kastner 1982) are improved yields through better water-binding, and better fat emulsifying properties. In our model-experiments, with relatively small batches of pre-rigor pork, most hot processed products were similar in quality as cold processed controls. Although hot processed bacon did take up to 2.4% more brine during curing, most of the weight gain was lost again during draining, resulting in a nett advantage of only 0.4%. Hot processing of hams, excised at approximately 45 min post mortem yielded a product with superior waterbinding properties. Pre-rigor processed hams from one side of the carcass had significantly high yields than post-rigor processed hams from the other carcass side. Also, yields appear to depend on the speed of glycolysis, fast glycolysing muscle generally having lower yields: in the pre-rigor group (N.B. between-carcass comparisons) approximately 1% lower. Our findings once more emphasise the importance for cooked ham processing of avoiding stress during lairage (Troeger and Woltersdorft 1987). In luncheon meat the consistency of the pre-rigor processed product, as measured with a penetrometer, was slightly higher than in the post-rigor processed product, particularly at high F_0. We have no adequate explanation for this finding. The reduced water exudation of the luncheon meat confirms the superior water-binding properties of hot boned pork. In sausage production the most striking feature observed was a marked reduction of the proportion of pork sausages with fat separation. This constitutes a major advantage both in phosphate-free sausages as well as for sausages with minimum quantities of pork.

CONCLUSIONS

Hot boning of pig carcasses results in higher carcass yields and in fresh pork of similar sensory quality. The use of pre-rigor pork with superior water-binding properties promises higher yields when processing pork products. The latter is particularly promising at a time the meat industry is faced with increasing pressure to reduce sodium and phosphate levels.

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