51st International Congress of Meat Science and Technology
August 7-12, 2005 – Baltimore, Maryland USA

ASSESSMENT OF CARCASS HANGING TECHNIQUE AND CONDITIONING TEMPERATURE ON QUALITY PARAMETERS OF CURED PIGMEAT PRODUCTS

Massafra, A., Walsh, H. M., Casey, I., Murphy, S.C., Hogan, S.A., O'Grady M.N.* and Kerry, J.P.

Department of Food and Nutritional Sciences, National University of Ireland – University College Cork, Cork, Ireland

Key Words: pigmeat, cured, hanging, temperature conditioning.

Introduction

A number of post-slaughter treatments can be used to influence meat tenderness, such as electrical stimulation, pelvic suspension and conditioning. To improve tenderness of meat, by preventing some muscles from shortening during rigor mortis, carcasses may be suspended from the aitch bone (pelvic suspension) shortly after slaughter instead of using the Achilles tendon (Hostetler *et al*., 1975).

As is the case for electrical stimulation, pelvic suspension has been applied primarily to increase beef tenderness. However, pelvic suspension has also been shown to improve tenderness in pork (Moller and Vestergaard, 1986; Taylor *et al*., 1995), as well as reduce drip loss (Dransfield *et al*., 1991) and the practice of pelvic suspension has been adopted by both beef and pork industries to improve tenderness.

The post mortem chilling procedure of blast-chilling shortens the carcasses' chilling time and reduces the occurrence of PSE meat (Milligan et al., 1998). Blast-chilling is thus attractive to the pork industry and is now commonly used. However, this more efficient chilling has been reported to produce tougher pork (Dransfield and Lockyer, 1985; Moller & Vestergaard, 1986). Tougher meat can be related to the phenomenon of cold-shortening, which occurs in meat that is chilled below 10°C pre-rigor, when the adenosine triphosphate (ATP) level is still high (pH above 6.0) (Bendall, 1973; Bendall, 1975). A milder chilling regime would therefore be preferable when tenderness is the quality aspect of highest priority (Josell et al., 2004).

Objectives

The effects of temperature conditioning and hanging method on the quality of cured meat products are not well documented. Therefore, the objective of this study was to improve processed pork quality by a combination of alternative hanging methods and higher temperature conditioning.

Methodology

Large White × Landrace cross pigs (n=32) of approx 95kg live weight were slaughtered by exsanguination after CO_2 stunning. Following evisceration, pigs were centrally split and the left sides of all carcasses were hung from the Achilles Tendon (AT) and the right sides were suspended from the Pelvic Bone (PB). The groups were then halved and subjected to either (i) conditioning in air at 17ºC for ~3 hours (hrs) followed by air at 1ºC for 21 hrs (n=16), or (ii) no conditioning and were chilled at 1ºC for 24 hrs (n=16). Ham, shoulder and loin primal cuts were then removed from each carcass. Excess fat, connective tissue, bone and rind were removed from the primal cuts prior to injection (15% weight increase) with brine (12% salt, 0.15% sodium nitrite, 0.15% sodium nitrate, 0.5% sodium ascorbate, 2.5% potassium phosphate and 3.5% sugar). Raw hams and shoulders were subsequently vacuum tumbled at 10 rpm for 1 hr (0°C). Hams were stuffed into elasticated nettings (Micromesh Net, 8 inch) and vacuum packed in heat-shrinkable cooking bags (Cryovac BB4L) while the shoulders were vacuum packed into aluminium moulds using heat-shrinkable cooking bags (Cryovac BB4L) and cooked to an internal temperature of 72°C and at a relative humidity of 99%. Ham, shoulder and loin slices were flushed with 70% N_2 : 30% CO_2 for storage under modified atmosphere conditions. All samples were stored for up to 18 days in a refrigerated display cabinet (4°C, 616 lux fluorescent lighting).

The extent of lipid oxidation was assessed by measuring thiobarbituric acid reacting substances (TBARS) using the method of Ke *et al*. (1977) and expressed as mg malonaldehyde/kg sample. CIE L* and a* values were recorded using a Minolta chromameter CR-300 (Minolta Camera Co., Chou-Ku, Osaka 541, Japan). Warner Bratzler shear force (WBSF) was measured using the blade and guillotine attachment of the SMS TA.XT2i Texture Analyser (Stable Micro Systems, UK). Cook loss of loin samples was assessed gravimetrically.

A full-repeated measures ANOVA was conducted to investigate the effects of hanging, temperature and day on meat quality using SPSS 11.0 software package for Windows (SPSS, Chicago, IL, USA).

Results & Discussion

Hanging methods had no significant effects on WBSF determined for any of the cured products examined (Table 1). This finding is at odds with the generally accepted principle that pelvic bone suspension can aid in improving meat tenderness (Desmond and Kenny, 2005). In general, higher temperature conditioning of pork products did not improve tenderness although hams hung by both AT and PB were significantly ($p<0.001$) more tender at the end of the 18 day storage period. This effect may have been due to the combined effects of prevention of early *post-mortem* cold shortening, promotion of proteolysis and the tenderising effects of ageing. Rees *et al*. (2002) reported a temperature of 14 °C as suitable for conditioning of pork in order to enhance tenderness without detrimentally affecting other quality attributes and such a recommendation is supported, in the case of hams, by the present study.

The levels of lipid oxidation in the cured pork products examined (Table 2) remained low throughout storage and below that (0.5mg malonaldehyde/kg sample) detectable by trained sensory panelists (Lanari *et al*., 1995). Such low values are the result of the presence of known antioxidants (nitrites, phosphates and ascorbates) in the brine solution and anoxic packaging conditions. Hanging method did not significantly affect shelf life stability. Trends observed for the effects of temperature were not consistent for the three primal cuts. In the case of hams, TBARs values were, in general, lower for samples conditioned at 17°C. The opposite effect was found for shoulders and loins. No pertinent literature was available for comparison of such effects.

Colour stability during refrigerated storage was not influenced by hanging method Table 3). Higher conditioning temperature did, however, significantly affect L* values of ham samples, which were lower (paler) than corresponding samples conditioned at 1°C. This result contrasts with the findings of Rees *et al*. (2002) who reported a linear relationship between L* values and conditioning temperature. In general, L* values of shoulders and loins were not affected by conditioning temperature. In the case of a* (redness) values, higher conditioning temperature resulted in a decreased values during storage of all three primal cuts.

Hanging method had no significant effect on cook loss of cured products during storage (Table 4). Overall, pork conditioned at 17°C had lower cook loss and this effect decreased with storage time. Higher temperature conditioning may have caused a decrease in the extent of muscle contraction early *post mortem* and a subsequent decrease in moisture losses upon cooking.

Conclusions

Hanging method did not influence the quality attributes of cured hams, shoulders and loins. Conditioning temperature did affect the pork quality although these effects were not consistent between the cuts examined. The results suggest that the effects of temperature conditioning may be muscle dependent and that the use of such a processing technique holds promise as a means of controlling the quality of pork products.

References

Bendall, J.R. 1973. Postmortem changes in muscle. In: Structure and function of muscle, 2nd edition, Part 2. Bourne, G.H.(ed.). Academic Press, New York.

Bendall, J.R. 1975. Cold contracture and Atp-turnover in red and white musculature of pig, postmortem. J. Sci. Food Agric. 26:55–71.

Desmond E.M. and Kenny. T. A. 2005. Effect of pelvic suspension and cooking method on the processing and sensory properties of hams prepared from two pork muscles. Meat Sci. 69:425–431.

Dransfield, E., and Lockyer, D.K. 1985. Cold shotening toughness in excised pork M-Longissimus dorsi. Meat Sci. 13:19–32.

Dransfield, E., Ledwith, M.J., and Taylor, A.A. 1991. Effect of electrical stimulation, hip suspension and ageing in chilled pig meat. Meat Sci. 29:129–139.

Fisher, A.V., Pouros, A., Wood. J.D., Young-Boong, K., and Sheard, P.R. 2000. Effect of pelvic suspension on three major leg muscles in the pig carcass and implications for ham manufacture. Meat Sci. 56:127.

Hostetler, R.L., Carpenter, Z.L., Smith, G.C., and Dutson, T.R. 1975. Comparison of postmortem treatments for improving tenderness of beef . J. Food Sci. 40:223–226.

Josell, A., von Seth, G., and Tornberg, E. 2004. Sensory and meat quality traits of pork in relation to post-slaughter treatment and RN genotype. Meat Sci. 66:113–124.

Ke, P.J., Ackman, R.J., Linke, B.H., and Nash, D.M. 1977. Differential lipid oxidation in various parts of frozen mackerel. J. Food Tech. 12:37–47.

Lanari, M. C., Schaefer, D. M., Cassens, R. G. and Scheller, K. K. 1995. Dietary vitamin E supplementation and discolouration of pork bone and muscle following modified atmosphere packaging. Meat Science. 41: 337–350.

Milligan, S.D., Ramsey, C.B., Miller, M.F., Kaster, C.S., and Thompson, L,D. 1998. Resting of pigs and hot-fat trimming and accelerated chilling of carcasses to improve pork quality. J. Anim. Sci. 76:74–86.

Moller, A.J., and Vestergaard, T. 1986. Effects of altered carcass suspension during rigor mortis on tenderness of pork loin. Meat Sci. 18:77–87.

Rees, M.P., Trout, G.R., and Warner, R.D. 2002. Tenderness of pork m. longissimus thoracis et lumborum after accelerated boning. Part I. Effect of temperature conditioning. Meat Sci. 61: 205–214.

Taylor, A.A., Perry, A.M., and Warkup, C.C. 1985. Improving pork quality by electrical stimulation or pelvic suspension of carcasses. Meat Sci. 39:397–337.

Acknowledgement

Funded by the Irish Government under the National Development Plan 2000 – 2006.

Tables and Figures

Table 1. Effect of hanging method and conditioning temperature on Warner Bratzler shear force of cured pork hams, shoulder and loins.

	Primal Cut (Time, Days)		AT 1ºC	AT 17ºC	PB 1ºC	PB 17ºC	Significance H	Significance T
WBSF (kg)	Ham	1	2.56	2.69	2.15	2.22	ns	ns
		4	2.38	2.18	2.58	1.84	ns	ns
		8	2.70	2.33	2.45	1.95	ns	ns
		12	3.00	2.17	3.12	2.86	ns	ns
		18	4.92	2.00	3.91	2.65	ns	***
	Shoulder	1	2.60	3.02	2.91	3.59	ns	ns
		4	2.79	2.82	3.61	3.74	ns	*
		8	3.39	2.72	3.36	2.95	ns	ns
		12	2.68	2.56	2.65	2.77	ns	ns
		18	3.47	4.00	2.54	2.95	ns	*
	Loin	1	4.14	3.83	3.85	3.55	ns	ns
		4	3.51	3.26	3.60	3.27	ns	ns
		8	3.92	3.73	3.25	3.12	ns	**
		12	3.55	3.52	3.63	3.25	ns	ns
		18	3.16	3.09	3.54	3.45	ns	ns

Significance: * = $P < 0.05$, ** = $P < 0.01$, P = $P < 0.001$, ns = non-significant; $P > 0.05$.

Table 2. Effect of hanging method and conditioning temperature on lipid oxidation (TBARS) of cured pork hams, shoulder and loins held during storage at 4 °C.

	Primal Cut (Time, Days)		**Hanging method**				**Significance**	
			AT		***PB***			
			Temperature (T)					
			1ºC	***17ºC***	***1ºC***	***17ºC***	***H***	***T***
TBARS (mg MDA/kg)	Ham	1	0.27	0.08	0.15	0.09	ns	**
		4	0.13	0.09	0.10	0.10	ns	ns
		8	0.13	0.08	0.11	0.13	ns	ns
		12	0.18	0.09	0.11	0.08	ns	**
		18	0.14	0.13	0.19	0.12	ns	*
	Shoulder	1	0.10	0.18	0.12	0.17	ns	ns
		4	0.09	0.16	0.11	0.14	ns	*
		8	0.10	0.13	0.08	0.15	ns	*
		12	0.18	0.10	0.10	0.08	*	*
		18	0.09	0.13	0.06	0.13	ns	**
	Loin	1	0.10	0.13	0.08	0.13	ns	*
		4	0.05	0.08	0.05	0.10	ns	*
		8	0.07	0.12	0.05	0.08	ns	***
		12	0.08	0.08	0.07	0.08	ns	ns
		18	0.04	0.11	0.04	0.10	ns	***

Significance: * = P < 0.05, ** = P < 0.01, P = P < 0.001, ns = non-significant; P > 0.05.

Table 3. Effect of hanging method and conditioning temperature on colour stability of cured pork hams, shoulder and loins held during storage at 4 °C.

Test	Primal Cut (Time, Days)		Hanging method *AT* Temperature (T) 1ºC	*AT* 17ºC	*PB* 1ºC	*PB* 17ºC	Significance *H*	Significance *T*
L* Values	Ham	1	62.80	58.25	62.90	57.20	ns	**
		4	63.70	56.31	64.61	55.89	ns	***
		8	63.66	57.36	65.41	56.33	ns	***
		12	61.35	57.17	62.54	53.09	ns	***
		18	59.36	56.19	60.67	52.07	ns	***
	Shoulder	1	57.14	54.15	58.03	54.56	ns	*
		4	53.01	55.44	54.51	54.97	ns	ns
		8	52.41	52.56	53.57	52.90	ns	ns
		12	56.56	55.93	58.10	54.64	ns	ns
		18	52.08	52.99	53.66	51.64	ns	ns
	Loin	1	41.62	43.78	40.28	44.02	ns	ns
		4	42.08	42.26	41.13	44.00	ns	ns
		8	41.08	43.99	40.05	41.30	ns	ns
		12	44.14	39.65	43.87	41.29	ns	**
		18	40.14	38.55	41.30	42.47	*	ns
a* values	Ham	1	7.06	6.54	7.2	6.71	ns	ns
		4	8.38	6.83	8.41	6.93	ns	*
		8	7.73	6.42	8.25	6.24	ns	**
		12	5.02	6.51	7.12	6.93	ns	ns
		18	3.20	5.22	5.38	5.33	ns	ns
	Shoulder	1	6.41	7.65	7.15	6.69	ns	ns
		4	5.87	7.86	6.39	8.63	ns	**
		8	7.5	8.61	6.42	7.75	ns	ns
		12	4.61	7.65	5.9	7.6	ns	**
		18	5.88	6.42	5.65	7.49	ns	ns
	Loin	1	1.81	3.14	2.51	2.55	ns	ns
		4	1.16	3.72	2.01	3.85	ns	***
		8	1.41	2.84	1.4	2.53	ns	**
		12	0.89	2.95	1.43	2.41	ns	**
		18	1.5	2.75	1.92	2.16	ns	ns

Significance: * = P < 0.05, ** = P < 0.01, P = P < 0.001, ns = non-significant; P > 0.05.

Table 4. Effect of hanging method and conditioning temperature on cook loss of cured loins held during storage at 4 °C.

	Primal Cut (Time, Days)		Hanging method: *AT* 1ºC	*AT* 17ºC	*PB* 1ºC	*PB* 17ºC	Significance *H*	Significance *T*
Cook loss (%)	Loin	1	30.41	24.38	30.56	24.76	ns	***
		4	29.83	25.25	29.57	24.94	ns	*
		8	25.21	27.01	27.94	26.44	ns	ns
		12	24.43	25.42	26.06	24.45	ns	ns
		18	24.47	22.62	25.76	22.38	ns	ns

Significance: * = P < 0.05, ** = P < 0.01, P = P < 0.001, ns = non-significant; P > 0.05.