

SENSORY QUALITY OF DIFFERENT PORK CUTS WAS INFLUENCED BY SEX, CUT TYPE, COOKING METHOD AND ENDPOINT TEMPERATURE

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Abstract – This study involved 60 pigs of three sexes (entire male, female, surgical castrates; n=20 per sex). Three primal cuts were evaluated (loin, silverside and shoulder) and three cooking methods (roast, stir fry (all primals) and grilling as steaks (loin only)). Each cut was either aged for 2 or 7 days (d) post-slaughter and cooked to either a 70 or 75°C endpoint temperature. The objective of this study was to determine the influence and size of these factors, and their interactions, to improve pork consistency and reduce the fail rate of pork to less than 10%. Overall liking of pork was influenced, in order of importance, by flavour, tenderness, juiciness and aroma. Juiciness, flavour, overall liking, quality grade and intramuscular fat content were influenced by sex of the pig, with lower scores obtained for pork from entire males than surgical castrates, with females intermediate. Fail rate, based on the percentage of consumer evaluations that scored either 1 (unacceptable) or 2 (below average) for quality grade was higher for pork from entire males than from females and surgical castrates. Cooking effects were large for all sensory variables assessed. Overall, loin steaks and silverside roasts obtained the lowest scores for overall liking and had higher fail rates than other cuts. Finally, only stir fry obtained from the shoulder achieved a fail rate of less than 10%.

Key Words – Pork, Eating quality, Pathway

I. INTRODUCTION

The impact of key production, processing and post-slaughter factors on the eating quality attributes of fresh pork has been investigated [1]. However, it was identified that this approach had limitations in that only the effect of singular factors on eating quality could be effectively quantified due to the nature of the data available. It was highlighted that there is little existing information on different muscles, other than the loin, or extensive studies that compared different cooking methods and final

endpoint temperatures on sensory attributes of pork. This is needed for the system to be cuts-based, rather than a carcass based system. Considerable difficulties will be experienced in finalizing pathway recommendations for the Australian pork industry if relationships between the different production, processing and post-slaughter pathway options remain unclear.

The presence of boar taint remains a significant issue for Australian consumers. Recent consumer research conducted by Australian Pork Limited identified that the bad taste and smell were more likely to cause a reduction in purchase frequency of pork than other meats whilst one in three consumers buy pork less frequently due to a bad product experience. Boar taint cannot be effectively managed by slaughtering animals at 64 ±5 kg [2]. Options to address this include physical castration of males and the use of the boar taint vaccine to result in immunocastration of entire males.

Previous studies have identified improvements in pork sensory quality following ageing for 7-10 days post-slaughter [3-6]. It is noteworthy that post-slaughter ageing is also included as an intervention in the Meat Standards Australia systems for both beef [7, 8] and lamb [9]

Pork tends to be overcooked by Australian consumers due to unfounded food safety concerns associated with cooking pork to a rare, medium rare or medium degree of doneness. Information that demonstrated eating quality benefits associated with cooking different pork cuts to a 70°C rather than to a medium well done (75°C) degree of doneness is therefore required for Australian consumers.

We hypothesized that entire males would produce pork of lower eating quality than females or surgical castrates; ageing for 7d post-slaughter, rather than 2d post-slaughter, would improve sensory scores for tenderness, juiciness and flavour; cooking to an endpoint temperature of 70°C, rather than 75°C, will minimize moisture loss and improve consumer scores, and eating quality of different cuts will vary with cooking method used.

The objective of this study was to determine both the influence and effect size of a number of factors (including gender, ageing period, endpoint temperature, cut type, cooking method), and their interactions, on consumer acceptability of pork to improve pork consistency and reducing the fail rate of pork to less than 5%.

II. MATERIALS AND METHODS

Sixty Large White x Landrace pigs were sourced for this study and randomly allocated to gender treatment (n=20 per gender) – females; entire males; surgical castrates. Males allocated to the surgical castrate treatment were castrated at 1 day of age and all pigs were injected with iron at birth. Animals were slaughtered over two days at 22 weeks of age. During the finisher phase, all pigs were finished on a 13.8 DE/MJ kg diet containing 13.0% crude protein diet with 0.78% available lysine. Fat samples from each carcass were assessed for androstenone and skatole concentrations. Carcass weight and fat depth at the P2 site was obtained on the slaughter floor and following chilling at 4°C for 24 h, carcasses were boned at 24 h post-slaughter. The *M. longissimus* (loin), *M. biceps femoris* (silverside), *M. triceps brachii* (bolar blade) and *M. supraspinatus* (chuck tender) were collected from both sides of each carcass. For the loin, four 2.5 cm thick steaks were sliced from the caudal end of each loin, derinded and denuded of subcutaneous fat, Two pieces for roasting stir frying were then prepared. For the silverside, a roasting piece was cut, followed by another piece for stir fry. The bolar blade (*M. triceps brachii*), for roasting, and chuck tender (*M. supraspinatus*), for stir fry, were removed from the pork shoulder. Ageing period (2 or 7 days) and endpoint temperature (70 or 75°C) were randomly allocated to each side. All labeled and individually vacuum packaged cuts were boxed and frozen to -20°C at either 2 or 7 days post-slaughter, depending

on treatment allocation. Frozen cuts were then transported to the sensory facility via truck for sensory assessment. Each cut type from each side of the carcass was evaluated by four consumers. A 0-100 continuous line scale was used by consumers to evaluate each sample for aroma, tenderness, juiciness, flavour and overall liking (0=like extremely, very tender, very juicy to 100=dislike extremely, not tender, not juicy). Each sample was also assessed for quality grade score on a 1-5 scale (1=unsatisfactory, 2=below average, 3=average, 4=above average and 5=excellent). Fail rate refers to the percentage of consumer evaluations for quality grade that scored either a 1 or a 2. A total of 480 consumers evaluated 3360 samples in this study. Sensory data was analysed using the statistical package, R. Genstat 12 was used for analysis of carcass and meat quality data.

III. RESULTS AND DISCUSSION

Although no differences in average daily gain, final liveweight or hot carcass weight were found due to sex (Table 1), surgical castrates were fatter ($P<0.001$) at the P2 site than entire males and females. Dressing percentage of entire males was lower than females, with surgical castrates intermediate. In total, 25% of entire male carcasses had androstenone levels of $>1\mu\text{g/g}$, whilst the incidence of entire male carcasses with levels of skatole and androstenone exceeding the threshold levels of $>0.2\mu\text{g/g}$ and $1\mu\text{g/g}$, for skatole and androstenone, respectively was 15%. Intramuscular fat levels of pork from surgically castrated males were higher in the loin ($P=0.009$) and silverside ($P=0.002$) muscles, but not the bolar blade, compared to those from entire male and female pigs.

Across all treatment combinations, scores for overall liking, flavour, juiciness and quality grade of pork from surgical castrates were higher than those from entire males, with females intermediate for these sensory traits. Based on these findings, entire males should not be included as part of an eating quality system to deliver pork of guaranteed high eating quality to consumers.

Table 1: Predicted means and standard error of the difference (s.e.d.) for effect of sex on final liveweight (LWT, kg), carcass parameters, androstene and skatole concentrations, intramuscular fat content (IMF), sensory attributes and fail rate (%) of pork

	SC	EM	F	s.e.d	P value
Final LWT	98.1	95.7	96.6	2.55	0.639
P2 fat depth	14.8	9.8	10.3	0.85	<0.001
HCW (kg)	76.3	72.6	75.8	2.12	0.176
DP (%)	77.7	75.8	78.5	0.61	<0.001
Androstene	108	753	n.a.		
Skatole	38	185	45		
IMF					
Loin	3.46	2.47	2.89	0.317	0.009
Silverside	2.79	1.76	2.15	0.283	0.002
Bolar blade	1.77	1.78	1.81	0.220	
Aroma	60.0	58.0	59.4	1.39	0.353
Tenderness	54.5	51.3	51.9	1.63	0.122
Juiciness	55.5	51.6	52.9	1.46	0.035
Flavour	60.8	56.6	57.9	1.41	0.017
Overall liking	59.5	55.2	56.6	1.45	0.018
Quality grade	3.39	3.32	3.34	0.057	0.026
Fail rate (%)	17.7	19.1	23.0		

Overall liking was highly correlated with flavour ($R=0.939$), juiciness ($R=0.848$), tenderness ($R=0.828$) and aroma ($R=0.705$). The strong relationship between these variables was evidenced by the prediction equation for overall liking included the other four key variables (across all treatments): Overall liking = $-0.774 + 0.618 \times \text{Flavour} + 0.235 \times \text{Tenderness} + 0.156 \times \text{Juiciness} + 0.019 \times \text{Aroma}$ ($P<0.001$; $R^2=0.893$, SE 8.2). Overall liking of pork was therefore influenced, in order of importance, by flavour, tenderness, juiciness and aroma. The importance of flavour on overall liking of pork concurs with Channon et al. (2001) with pork loin steaks and topside roasts. Overall liking was the most important predictor of quality grade - Quality grade score = $1.389 - 0.001 \times \text{Aroma} + 0.003 \times \text{Tenderness} + 0.004 \times \text{Flavour} + 0.029 \times \text{Overall liking}$ ($P<0.001$; $R^2=0.724$, SE 0.53).

In addition to sex of the pig, both cut type ($P<0.0001$) and cooking method ($P<0.0001$) influenced overall liking of pork (Table 2). Overall liking scores of loin steaks were 10.0 units lower ($P<0.0001$) than the average score of the other cut x cooking method combinations. When loin steaks were cooked to 75°C, overall liking scores were 4.7 units lower ($P=0.006$) than when cooked to an internal temperature of 70°C. Overall liking scores for loin steaks were 11.6 units and 5.1 units lower

than the other cut x cooking methods when cooked to 75°C or 70°C internal temperature, respectively.

The fail rate, based on quality grade score, of silverside roasts and loin steaks were 36% and 30.2%, respectively. This presents significant issues for industry, given that silversides are very commonly prepared as leg roasts and loins are used as steaks and chops. The targeted fail rate of <10% for quality grade score was only achieved for shoulder stir fry, prepared from the chuck tender. Overall, fail rates of stir fried pork were lower than for roasts, regardless of primal. Loin steaks and silverside roasts had higher fail rates and lower overall liking scores than all other cuts.

Positive effects of cooking to an endpoint temperature of 70°C were found for stir fry and steaks for overall liking. However, lowering endpoint temperature to 70°C from 75°C across all cut x cooking method combinations was either not large enough to result in significant improvements in eating quality scores, when judged by consumers for the main effect of endpoint temperature, or different cuts from different muscles of the carcass need to be cooked differently to optimize their eating quality.

IV. CONCLUSION

This study demonstrated that both ageing for 7 days and cooking to 70°C do not result in sizeable improvements in product consistency, especially at a cuts level when different cooking methods are used. It also demonstrated that eating quality assessments of one cut, such as the loin, cannot be reliably used to determine effects of pathway interventions on eating quality consistency of different cuts, when cooked using different methods.

Further work is therefore still required to better understand the impact of different pathway interventions and size of potential interactions between muscle, cut type, cooking method used and final endpoint temperature as well as to extend this for immunocastrated males. Further work is required to improve eating quality performance of loins and silversides, particularly when cooked as a steak or roast. This is currently being addressed by the authors.

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Table 2: Effect of sex, ageing period, endpoint temperature, cut type(shoulder (SH), loin (LN) and silverside (SS) and cooking method (roast (R), stir fry (SF) and steak (S)) on sensory overall liking scores and average fail rates (%) for cut x cooking method

Sex	Ageing (d)	Temp (°C)	Cut x Cooking method							s.e.d.
			SH R	SH SF	LN R	LN SF	LN S	SS R	SS SF	
Entire male	2	70	61.1	68.6	50.8	55.7	52.3	41.5	58.9	1.30
	7	70	61.7	68.0	44.4	56.0	47.8	39.5	52.7	
	2	75	68.8	74.1	57.4	54.9	44.1	45.0	54.3	
Female	7	75	64.1	68.5	53.8	54.2	44.4	47.9	55.3	
	2	70	57.7	72.0	55.9	62.7	51.6	42.9	55.1	
	7	70	65.4	71.9	58.1	60.6	47.7	43.5	54.2	
	2	75	60.0	67.7	58.2	58.8	40.4	45.6	48.9	
	7	75	61.3	73.4	57.9	62.6	49.7	48.0	52.2	
Surgical castrate	2	70	62.8	66.9	62.3	52.0	53.6	55.0	57.5	
	7	70	57.5	77.3	57.3	63.8	52.5	46.6	56.7	
	2	75	70.1	70.4	59.2	62.7	47.6	51.4	60.9	
	7	75	65.9	74.0	64.3	63.4	51.5	52.2	59.4	
Overall			63.0	71.1	56.6	58.9	48.6	46.6	54.8	
Fail rate (%)			12.1	5.4	19.2	15.2	30.2	36.0	21.5	