AITCHBONE HANGING OR AGEING FOR 7 DAYS IMPROVES PORK EATING QUALITY

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Abstract – The influence of processing site, carcase weight, hanging method and ageing period on eating quality attributes of pork was investigated in this study. A total of 144 Large White x Landrace female pigs from two carcase weight groups (60 kg and 80 kg) were slaughtered at one of three processors on the same two slaughter days, split and hung from either the Achilles tendon or the aitchbone on the slaughter floor. The *M. longissimus thoracis et lumborum* (LTL) was removed at 24 hours post-slaughter, individually vacuum packaged and aged for either 2 or 7 d at 0-2°C. Consumers were used to evaluate eating quality. Neither processing site nor carcase weight influenced tenderness, flavour or overall liking of pork. However, steaks from 60 kg carcases were juicier (P=0.035) compared to those from 80 kg carcases. Improvements in tenderness, flavour and overall liking of LTL were found due to aitchbone hanging (P<0.001) and ageing (P<0.001) for 7 days compared with Achilles-hung carcases and pork aged for only 2 days, respectively. No interaction was found between hanging method x ageing period for any of the sensory attributes (P>0.05). Ageing for 7 d or aitchbone hanging can be used to improve eating quality of pork consistently across different processing sites and carcase weights.

Key Words – Pork, eating quality, consumers

I. INTRODUCTION

Variable pork eating quality impacts negatively on re-purchasing frequency of pork by Australian consumers [1]. A major objective for Australian pork producers is to efficiently produce pork of consistently high eating quality. Understanding the impact of key pathway factors from production to consumption and the interactions between these different pathway factors on the eating quality of pork is required to provide industry with tools to optimise pork quality and assist with the implementation of an eating quality assurance system. Few studies have been conducted to determine the size of interactions between production, pre-slaughter handling, processing and post-slaughter carcase management on sensory attributes of pork. This study was conducted to quantify the effect of carcase weight, hanging method and post-slaughter ageing on sensory quality of pork and to determine the suitability of these interventions as part of an eating quality system for the Australian pork industry. In addition, this study also aimed to determine whether differences in processing sites contribute to sensory pork quality variability.

II. MATERIALS AND METHODS

A total of 144 female (Large White x Landrace) pigs of two liveweight ranges (75-85 kg and 100-110 kg) were supplied from one producer over two slaughter days. Pigs were weighed 6 d prior to slaughter and randomly allocated to one of three processors on the basis of stratified liveweight. A total of 72 pigs were slaughtered on each slaughter day across the 3 different sites. Pigs in each liveweight x processor group were then penned separately on farm, during transport and in lairage to minimise any potential effects on meat quality due to mixing. Pigs were held in lairage with access to water for 16 hours pre-slaughter and were off feed for 21 hours. One plant (Site B) used manual head only electrical stunning (240V, 50Hz, 4 sec) and CO_2 (85-90%) was used at Sites A and C.

On the slaughter floor, carcases were randomly allocated to either Achilles or aitchbone hanging and then placed in the same chiller for 24 hours at 4°C. Ageing treatment, either 2 or 7 d post-slaughter, was randomly allocated to each side within carcase. The design of this study was therefore a 3 (processor) x 2 (carcase weight) x 2 (hanging method) x 2 (ageing period) factorial experiment. A total of 288 muscles were

objectively measured and subjectively assessed for eating quality and quality grading by consumers.
Muscle pH and temperature decline was determined in the LTL, between the 12th and 13th thoracic rib from both sides of the carcase at 80 min, 3 h, 5 h and 8 h post-slaughter using a portable pH/temperature meter (Jenco Electronic Ltd, Model 6009) fitted with a polypropylene spear-type gel electrode (Ionode IJ42S, Brisbane, QLD) and a temperature probe.

At 24 h post-slaughter, LTL muscles from both sides of the carcase were individually labelled, vacuum packaged and chilled at 2°C and following ageing for the required period, prepared into six steaks of 2.5 cm thickness for consumer evaluation. All steaks were individually labelled and frozen at –20°C until required. Muscle samples for assessment of intramuscular fat were also obtained adjacent to the 7th and 8th thoracic rib, freeze dried for 7 days and fat was extracted using diethyl ether.

After thawing at 2°C for 24 hours, pork steaks were cooked for 5 min using Silex grills set at 190°C. All cooked steaks were then rested for 2 min and then cut in half width ways prior to presentation. Pork steaks attained a final internal temperature of 75°C. Any fat selvedge was removed after cooking.

A total of 852 consumers evaluated 3456 half steaks. Each muscle was assessed by 12 consumers for odour, tenderness, juiciness, flavour and overall quality, with two consumers assessing each steak. A line scale was used to assess eating quality on a 0 to 100 scale. Flavour, odour and overall quality were assessed using 0 = dislike extremely to 100 = like extremely, with the midpoint nominated with the descriptor of 'neither like nor dislike'. The descriptor used for tenderness was: 0 = very tough to 100 = very tender. Juiciness was scored using: 0 = very dry to 100 = very juicy. Each consumer was also asked to grade steaks into one of five categories: 1= Unsatisfactory; 2= Below Average; 3= Average; 4= Above average or 5=Premium.

For each sensory attribute, mean values were calculated for each side of all animals in this experiment using Restricted Estimated Maximum Likelihood [2]. Variance components (random effects) corresponding to consumer panel sessions, consumers within sessions and samples within consumers within sessions were fitted. Adjusted means (fixed effects) for all animals and the two sides of each animal were obtained from the mixed model analysis. The adjusted means for the sides of each carcase were then analysed using analysis of variance (ANOVA). The ANOVA had four strata corresponding to days or slaughter groups, batches of animals, animals within batches and sides within animals. The six batches in each day were experimental units for the six combinations of processor and carcase weight group. The 12 animals in each group were the experimental units for the hanging method treatment and the two sides from each animal were the experimental units for the ageing period treatment. This experiment was therefore a two-phase experiment; the first phase was the slaughter phase and the second phase the sensory evaluation phase.

III. RESULTS AND DISCUSSION

Overall, processing site did not influence (P>0.05) juiciness, flavour, overall liking and quality grade of pork steaks (Table 1). However, a tendency for pork from Site B to be more tender than that from Site A and C was observed (P=0.052). This may be explained by Achilles-hung carcases from Site B being more tender (P=0.032) compared with those from Sites A and C (Table 2). Although electrical stunning was used in Site B, the rate of muscle pH decline from 40 min to 8 hours post-slaughter did not explain these findings and was therefore not considered to contribute to this difference.

Steaks from 60 kg HCW carcases were juicier (P=0.035) than those from 80 kg HCW carcases (Table 2), however juiciness was not influenced by processing site, hanging treatment or ageing period. Growth rate differences, rather than age, were considered to account for liveweight differences of pigs allocated to 60 kg and 80 kg carcase weight groups as animals were sorted from the same pens in the finisher shed 6d prior to slaughter. Although different market segments are based on hot standard carcase weight (HSCW) and fat depth for fresh pork in Australia, these findings suggest that the eating quality attributes of pork

from carcases ranging from 55-90 kg HCW do not significantly differ.

Table 1: Effect of processing site (A,B,C), carcase weight (HCW) (60 or 80 kg), hanging method (Achilles or aitchbone) and ageing period (2 or 7 days) on tenderness (Tend), juiciness, flavour, overall liking and quality grade scores of the *M. longissimus thoracis et lumborum* (LTL) muscles.

Sensory attribute	Tend[a]	Juiciness[b]	Flavour[c]	Overall liking[c]	Quality grade[d]
Site A	53.9	58.6	60.1	59.1	3.25
Site B	57.8	60.1	62.0	60.9	3.37
Site C	54.1	58.8	60.8	59.1	3.24
l.s.d.	3.33	2.40	2.33	2.32	0.118
P	0.052	0.34	0.18	0.16	0.067
60 kg HCW	55.0	60.3	60.9	59.6	3.31
80 kg HCW	55.5	58.1	61.0	59.8	3.27
l.s.d.	2.72	1.96	1.90	1.90	0.097
P	0.67	0.035	0.97	0.84	0.37
Achilles	51.7	58.1	59.3	57.2	3.16
Aitchbone	58.8	60.2	62.7	62.2	3.41
l.s.d.	2.92	2.46	1.76	2.25	0.110
P	<0.001	0.09	<0.001	<0.001	<0.001
2 d aged	52.0	58.8	59.4	57.7	3.18
7 d aged	58.5	59.5	62.5	61.7	3.39
l.s.d.	1.70	1.57	1.34	1.46	0.068
P	<0.001	0.37	<0.001	<0.001	<0.001

[a] 0 = very tough to 100 = very tender; [b] 0 = very dry to 100 = very juicy; [c] 0 = dislike extremely to 100 = like extremely [d]0 = unsatisfactory to 5 = premium.

Table 2: Influence of hanging method (Achilles or Aitchbone) on sensory tenderness scores[†] of LTL steaks and rate of muscle pH decline (pH units/hour) from 40 min to 10 hours post-slaughter

	Sensory tenderness		Rate of pH decline	
Site	Achilles	Aitchbone	Achilles	Aitchbone
A	47.8	60.0	-0.030	-0.047
B	56.5	59.1	-0.046	-0.049
C	50.9	57.4	-0.082	-0.085
s.e.d.	2.25		0.043	
P	0.032		0.348	

[†] 0 = very tough to 100 = very tender

Tenderness, flavour, overall liking and quality grade scores of pork steaks were influenced by hanging method (P<0.001) and ageing period (P<0.001), with higher scores obtained for these three attributes from aitchbone-hung carcases and from those aged for 7 d post-slaughter. Despite improvements in eating quality resulting from aitchbone hanging in this study, this has not been adopted by the Australian industry given the additional labour requirement and chiller space required. Since this study was conducted (where pork was primarily distributed as carcases), large retailers and food service operators now demand boxed, vacuum packaged pork primals to be supplied thus improving industry's ability to supply pork that has been aged for more than 2 days post-slaughter. Improved tenderness associated with ageing of vacuum packaged pork LTL muscles for 7 days or more has previously been reported [3-6]. Ageing pork for 10 days post-slaughter was shown to improve tenderness to a greater extent than genotype (Duroc vs. Large White) or feeding level (*ad libitum* vs. 0.8 *ad libitum*) [4]. As the interaction between hanging method and ageing period was not significant (P>0.05) for any of the sensory attributes evaluated in this study, adoption of either strategy would result in improved eating quality.

In this study, 59% of LTL muscles had intramuscular fat concentrations ranging from 0.5 – 1.49%, with only 15% of samples found to have an intramuscular fat level of >2%. No difference in intramuscular fat content from 60 kg and 80 kg HSCW pigs was found (1.48% and 1.38%, respectively; s.e.d. 0.179). The correlation between intramuscular fat content and mean sensory tenderness and juiciness scores were also extremely poor (R^2=0.00008 and R^2=0.008, respectively). This may reflect the narrow range in intramuscular fat content present in the LTL muscle. Previous studies [7-10] reported positive effects of intramuscular fat content on sensory attributes of pork when levels of intramuscular fat were in excess of 2%. Therefore, it is suggested that the combination of low intramuscular fat content and Australian consumers typically cooking pork to a well done degree of doneness, may negatively impact on overall pork eating quality.

Table 3 Correlation matrix between the sensory attributes of tenderness, juiciness, flavour, overall liking and quality grade for pork LTL steaks

	Tenderness	Juiciness	Flavour	Overall liking
Juiciness	0.586			
Flavour	0.776	0.641		
Overall liking	0.866	0.672	0.879	
Quality grade	0.876	0.673	0.851	0.920

Overall, flavour and tenderness were the two most important factors that influenced consumer perceptions of overall liking for pork (Table 3). As females were used in this study, boar taint would not have influenced flavour or overall liking and this may have contributed to higher correlations of tenderness and flavour to overall liking than those reported in other studies. Several studies [4, 11] conducted with consumer panels have shown that both flavour and tenderness contribute to overall liking. However, in a study using trained taste panelists [12], overall acceptance of pork was related more to tenderness (r=0.81) than to taste intensity (r=0.67), off flavour (r=-0.43) and juiciness (r=0.38). The importance of flavour to overall quality of pork indicates that the Australian pork industry still faces considerable challenges with respect to a high relative risk of boar taint given that many male pigs are still left entire.

IV. CONCLUSION

This study demonstrated that post-slaughter interventions of hanging method and ageing period improved eating quality of pork. These factors were additive when steaks were cooked to a final internal temperature of 75°C, suggesting that these two interventions do not need to be introduced together as part of an eating quality assurance system to result in improved consumer satisfaction of pork. The outcomes of this study are being used in the development of a predictive eating quality model for Australian pork [13].

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