RESEARCH REPORT

PORK QUALITY

Title: Influence of Harvest Processes on Pork Loin and Ham Quality
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I. Abstract

The objective of this trial was to determine the impact of harvest processes on pork quality characteristics. Sixty-four Duroc X Yorkshire pigs were randomly assigned to a 2X2-treatment arrangement to determine the effect of the interval between sticking and scalding (dwell time 5 or 10 min) and duration of scalding (5 or 8 min) on pork loin and ham quality. All carcasses entered the cooler 50-min postmortem (PM). Blood was collected per minute for the first three minutes after sticking and total blood yield was determined after five minutes. Temperature and pH of the longissimus dorsi (LD) and semimembranosus (SM) were measured at 45 min, 2, 4, 6, and 24-h PM. Hunter L*, a*, and b* values were determined on the LD, SM, and biceps femoris (BF). Purge loss was measured on the SM, BF, and the sirloin. Drip loss was measured from LD chops after 1 and 5 d of storage. Warner-Bratzler shear force (WBS) measurements were determined on LD chops aged 1, 3, 5, and 7 d PM. The first three minutes after sticking yielded 99.2% of the total collected blood. Temperature and pH of the LD and SM were not influenced by dwell time or scald time. Purge and drip loss values were not different among treatments. Hunter L* values showed no treatment effects for the LD, SM, or BF. The 8 min scald treatment resulted in significantly higher ($P < 0.002$) LD a* values than the 5 min scald time. SM muscles in the 10 min dwell time treatment had significantly lower ($P < 0.02$) b* values than 5 min dwell times. BF muscles had significantly lower ($P < 0.005$) a* and b* values in the 10 min dwell time compared to the 5 min treatment. The 10 min dwell time resulted in significantly higher ($P < 0.02$) WBS measurements (d 1 and d 3) compared to the 5 min dwell time. The 8 min scald time resulted in significantly higher ($P < 0.05$) WBS values (d 7) compared to the 5 min treatment. Dwell time and scald time did not influence overall pork quality when carcasses entered the cooler at the same time point PM.

II. Introduction

Variation in fresh pork color, texture and water holding capacity continues to be a significant concern to the pork industry. If pork produced in the United States is to successfully compete in the global market, issues relating to product quality and uniformity must be addressed. Pork quality is influenced by many system "inputs". These include genetics, nutrition, on-farm handling, transport, pre-slaughter handling, early postmortem processing, evisceration, chilling and fabrication (Meisinger, 1999). It is clear that genetics can have a profound effect on quality (Lonergan et al., 2001, Cameron et al., 1999). It is also clear that necessary handling and processing steps will either sustain or diminish the pork quality potential defined by the genetics and nutritional management of the pig. In essence, the pre-slaughter inputs (genetics, nutrition, transport and handling) set the stage for the response to the slaughter process (Sosnicki et al., 1998). Harvest and processing steps cannot improve quality defined by the pre-slaughter inputs. Rather, the harvest processes must be developed with the goal of maintaining quality.

Postmortem muscle metabolism has a significant role in determining pork texture, water binding capacity and tenderness. Postmortem production of lactic acid through glycolytic pathways can significantly alter pork quality. Variations in the *rate* (Piedrafita et al., 2001) or *extent* (LeRoy et al., 1990) of lactic acid production have been attributed to genetic factors such as the halothane gene or the RN gene. Products harvested from animals with these genetic conditions are likely to have very poor texture and water binding characteristics and do not perform well in fresh or further processed meat systems. Carcass handling early in the harvest process (most notably efficient removal of heat) can also have significant influence over pork quality. Many recommendations developed to maintain pork quality during the harvest process have focused on rapid processing and initiation of chilling (Honikel, 1999). It is also clear that other economic factors such as efficient utilization of processing employees, efficient removal of blood and effective removal of hair from the carcass must be considered. The current project has been designed to determine the consequence of changing the time of two key processing steps during harvest – exsanguination and scalding- on quality of fresh pork. Increasing “dwell time” prior to scalding may influence blood yield. Increasing scald time may decrease personnel needs in preparing the carcass for evisceration. This component of the pork processing chain is a vital link between producer inputs and final product quality. Information gained from this project will be used to allow processors to make informed decisions regarding early postmortem harvest procedures to produce high quality pork products as efficiently and consistently as possible.

III. Objectives

The objectives of this trial were to identify the extent to which timing during the harvest process influences pork quality.

- Determine how dwell time between exsanguination and scalding can influence pork color and water holding capacity.
- Determine the specific consequence of extending scalding time on pork color and water holding capacity.

IV. Procedures

32 crossbred (Duroc X Yorkshire) barrows and 32 (Duroc X Yorkshire) crossbred gilts were harvested at the ISU Meat Laboratory. 8 barrows and 8 gilts (average weight 113 kg) were slaughtered each week for a four-week period. A 2X2-treatment arrangement (16 pigs per treatment combination) was utilized. Carcasses were held for 5 or 10 minutes after sticking (dwell time) before entering the scald tank. Carcasses were placed in the scald tank for 5 or 8 minutes (water temperature of 60℃). Temperature

and pH were measured on the inside ham muscle (semimembranosus) and loin muscle (longissimus) at 45 minutes, 2, 4, 6, and 24 hours postmortem. All carcasses were placed into the cooler at 50 minutes postmortem. This was done to avoid the effect of some carcasses in the short dwell time or scald time treatment groups entering the cooler earlier postmortem and to allow specific investigation of the influence of harvest treatments on pork quality.

Hams and loins were removed from the left side of the carcass at 24 hours postmortem. Two 2.5 cm chops for the last rib region of the loin were used to determine subjective scores of color (NPPC), firmness, wetness, and marbling. Drip loss and Hunter L*, a* and b* values were measured on longissimus chops from the center loin. The sirloin end of the loin was utilized to determine purge loss in a vacuum package for a 6-day storage period.

Hunter L, a, and b values were obtained on the semimembranosus and biceps femoris of the ham. Ultimate pH of the semimembranosus and biceps femoris from each carcass were recorded. Portions (approximately 1.5 kg) of the semimembranosus and biceps femoris were utilized to determine purge loss in a vacuum package for a 6-day storage period.

V. Results

The total blood collected accounted for 3.59% of the live weight. Of the blood that was collected, 89.66% was collected in the first minute, and 7.91% was collected in the second minute (Figure 1). In other words, 97.57% of the total amount of blood collected was obtained in the first two minutes after sticking. These data are consistent with the results reported by Warris (1984). Very little blood was collected after two minutes, which provides evidence that processing facilities can decrease dwell time prior to scalding. Decreasing this time would allow for carcasses to enter the cooler at an earlier time postmortem, which may improve overall pork quality.

Our primary objective was to determine the impact of early postmortem processing traits on overall pork quality. Analysis was conducted with scald time, dwell time, harvest date, and sex of the animal as the independent variables. The longer scald time tended to result in a lower loin pH 45 minutes ($P = 0.058$) and two hours postmortem ($P=0.09$; Table 2). We observed lower temperatures at 2 hours postmortem in the semimembranosus muscles of carcasses in the shorter dwell time and scald time treatment groups (Table 3). These observations suggest that altering the harvest procedure has the potential to alter pH and temperature in the early postmortem period. Scald time had a significant effect ($P < 0.005$) on the 24-hour pH of the biceps femoris (Table 4).

Although the harvest treatments appeared to minimally influence pH and temperature decline early postmortem, treatment effects on pork quality measures were not consistently observed. Scald time had a significant effect ($P < 0.005$) on the a* value in the longissimus (Table 6). Dwell time had a significant effect ($P < 0.005$) on the b* value in the semimembranosus (Table 6). Dwell time had a significant effect ($P < 0.005$) on the a* and b* values in the biceps femoris (Table 6). No treatment differences were noted in purge loss (Table 7).

The 10 min dwell time resulted in significantly higher ($P < 0.02$) WBS measurements (d 1 and d 3) compared to the 5 min dwell time. The 8 min scald time resulted in significantly higher ($P < 0.05$) WBS values (d 7) compared to the 5 min treatment. Regression analysis suggests that lengthening the period between stunning and evisceration may be detrimental to tenderness of fresh pork. This observation should be investigated further.

It is necessary to develop harvest procedures that maintain the quality defined by pre-slaughter inputs. This report demonstrates that duration of the dwell time and the scald time has the potential to influence pork quality. It is expected that an abbreviated dwell time and/or scald time would decrease the amount of time necessary to reach the cooler. The impact of decreasing the processing time in combination with earlier chilling on pork color and water holding capacity remains to be defined.

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Figure 1. Cumulative blood loss during exsanguination

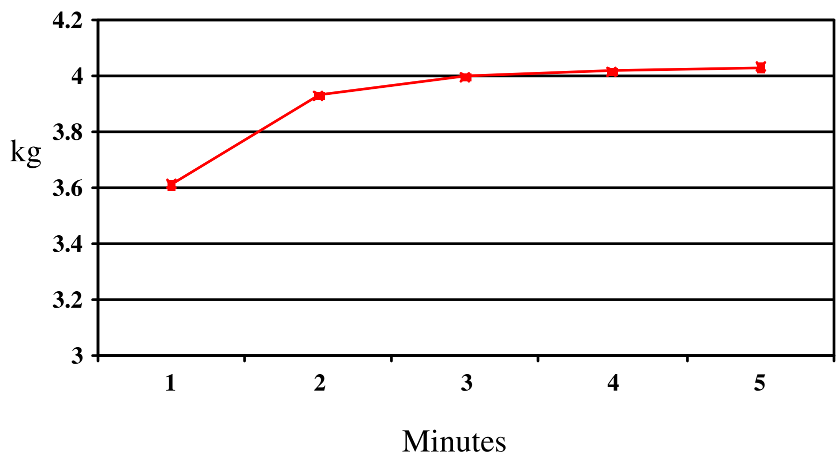

Table 1. Loin temperature decline means for scald and dwell time treatments.

	Scald Time					Dwell Time				
Loin Temp	5 min	SE	8 min	SE	P-value	5 min	SE	10 min	SE	P-value
45 min	35.83	0.22	35.83	0.27	0.99	35.89	0.22	35.78	0.27	0.71
2 hr	26.39	0.35	26.95	0.30	0.20	26.36	0.33	26.98	0.32	0.17
4 hr	15.21	0.38	15.59	0.36	0.38	15.22	0.37	15.58	0.38	0.39
6 hr	10.74	0.53	10.63	0.43	0.78	10.44	0.46	10.93	0.49	0.22
24 hr	2.09	0.11	2.10	0.08	0.84	2.17	0.10	2.03	0.08	0.07

Table 2. Loin pH means for scald and dwell time treatments.

	Scald Time					Dwell Time				
Loin pH	5 min	SE	8 min	SE	P-value	5 min	SE	10 min	SE	P-value
45 min	6.30	0.04	6.19	0.04	0.06	6.25	0.03	6.24	0.05	0.77
2 hr	5.95	0.05	5.82	0.06	0.09	5.88	0.05	5.88	0.06	0.98
4 hr	5.82	0.05	5.71	0.05	0.13	5.78	0.04	5.75	0.05	0.63
6 hr	5.72	0.04	5.67	0.03	0.28	5.70	0.03	5.69	0.04	0.88
24 hr	5.55	0.01	5.58	0.02	0.20	5.57	0.02	5.56	0.02	0.77

Table 3. Semimembranosus temperature decline means for scald and dwell time treatments.

	Scald Time					Dwell Time				
SM* Temp	5 min	SE	8 min	SE	P-value	5 min	SE	10 min	SE	P-value
45 min	36.25	0.23	36.33	0.25	0.79	36.22	0.22	36.36	0.26	0.61
2 hr	27.28	0.51	28.88	0.53	0.01	28.83	0.51	27.33	0.53	0.01
4 hr	21.44	0.43	21.59	0.37	0.46	21.38	0.44	21.67	0.34	0.78
6 hr	16.67	0.61	17.33	0.47	0.13	17.01	0.48	17.03	0.57	0.76
SM 24 hr	2.88	0.11	2.75	0.07	0.24	2.82	0.11	2.81	0.08	0.93
BF 24 hr**	3.00	0.10	2.89	0.06	0.24	2.97	0.09	2.93	0.08	0.62

*Semimembranosus, **Biceps Femoris

Table 4. Semimembranosus pH means for scald and dwell time treatments

	Scald Time					Dwell Time				
SM* pH	5 min	SE	8 min	SE	P-value	5 min	SE	10 min	SE	P-value

45 min	6.28	0.05	6.24	0.06	0.57	6.29	0.06	6.24	0.05	0.52
2 hr	5.90	0.05	5.83	0.06	0.39	5.88	0.06	5.86	0.05	0.82
4 hr	5.65	0.04	5.64	0.04	0.77	5.64	0.04	5.65	0.04	0.79
6 hr	5.55	0.02	5.57	0.03	0.39	5.55	0.02	5.56	0.02	0.82
SM 24 hr	5.56	0.02	5.63	0.03	0.05	5.59	0.03	5.60	0.02	0.59
BF 24 hr**	5.58	0.02	5.66	0.03	0.01	5.62	0.02	5.62	0.03	0.99

*Semimembranosus, **Biceps Femoris

Table 5. Summary of treatment means for loin quality traits.

	Scald Time					Dwell Time				
	5 min	SE	8 min	SE	P-value	5 min	SE	10 min	SE	P-value
NPPC Color[a]	2.55	0.11	2.56	0.11	0.92	2.52	0.10	2.59	0.11	0.61
Firmness[b]	1.88	0.07	1.88	0.07	0.99	1.84	0.08	1.91	0.07	0.56
Wetness[c]	2.02	0.09	1.88	0.09	0.27	1.84	0.09	2.05	0.09	0.12
Marbling[d]	1.64	0.10	1.63	0.10	0.91	1.58	0.08	1.69	0.12	0.43

[a] 1=pale, 6= dark

[b] 1= soft, 3 = firm

[c] 1= watery, 3= dry

[d] Marbling score is a prediction of the percent lipid.

Table 6. Influence of harvest treatments on longissimus dorsi (LD), semimembranosus (SM) and biceps femoris (BF) Hunter L*, a* and b* values.

	Scald Time					Dwell Time				
	5 min	SE	8 min	SE	P-value	5 min	SE	10 min	SE	P-value
Loin										
L*	56.07	0.54	57.10	0.58	0.21	56.96	0.60	56.21	0.53	0.36
a*	2.70	0.15	3.64	0.24	0.00	3.03	0.19	3.31	0.25	0.34
b*	15.25	0.22	15.80	0.25	0.08	15.72	0.19	15.33	0.29	0.21
Semimembranosus										
L*	52.29	0.46	51.36	0.48	0.16	52.13	0.47	51.53	0.47	0.36
a*	6.38	0.24	6.54	2.82	0.64	6.72	0.25	6.20	0.27	0.13
b*	16.14	0.21	15.67	0.28	0.12	16.29	0.22	15.52	0.27	0.01
Biceps Femoris										
L*	53.28	0.56	52.28	0.73	0.29	53.03	0.67	52.53	0.64	0.59
a*	7.37	0.25	7.80	0.26	0.16	8.04	0.21	7.13	0.28	0.01
b*	16.69	0.28	16.41	0.31	0.45	17.12	0.26	15.98	0.29	0.01

*Semimembranosus, **Biceps Femoris

Table 7. Influence of harvest treatments on purge (%) in sirloin, semimembranosus (SM) and biceps femoris (BF) roasts.

	Scald Time					Dwell Time				
	5 min	SE	8 min	SE	P-value	5 min	SE	10 min	SE	P-value
Sirloin	3.40	0.27	3.35	0.26	0.85	3.60	0.28	3.14	0.24	0.11
Semimembranosus	3.49	0.23	3.39	0.22	0.73	3.50	0.22	3.37	0.23	0.64
Biceps Femoris	3.28	0.30	2.78	0.27	0.20	3.01	0.28	3.05	0.29	0.91

Table 8. Influence of harvest treatments on loin chop Warner-Bratzler Shear force (WBS) values (kg) at 1,3,5 and 7 days postmortem.

	Scald Time					Dwell Time				
	5 min	SE	8 min	SE	P-value	5 min	SE	10 min	SE	P-value
Day 1	3.20	0.10	3.09	0.12	0.45	2.94	0.08	3.34	0.12	0.01
Day 3	3.52	0.10	3.65	0.12	0.43	3.39	0.10	3.78	0.11	0.01
Day 5	3.44	0.12	3.61	0.13	0.31	3.45	0.10	3.60	0.15	0.37
Day 7	3.42	0.12	3.76	0.14	0.05	3.49	0.11	3.69	0.15	0.24