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Analysis of commercial benchmarking data to assess the relationship of animal handling and carcass chilling rate on pork quality (#540)

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Introduction

Post-mortem (PM) pH is one of the key indicators of desirable pork quality (Lonergan, 2012). Numerous factors can influence PM pH decline, such as ante-mortem stress, feed withdrawal, lairage time, transportation length, and carcass chilling rate (Berg, 2006; Huff-Lonergan, 2012). Ante-mortem stress and carcass chilling rate are two of the most important factors in the development of a normal PM pH decline. The goal of this meta-analysis was to determine the relationship of animal handling and carcass chilling with pork quality traits in commercial slaughter plants by analyzing benchmark data collected by PIC in the past 4 years.

Methods

Data were collected in 26 commercial processing plants located in North America, South America, and Europe, totaling 8 different countries, from 2015 to 2019. Plants were classified based on chilling rate [Aggressive (AC) vs. Conventional (CC)] and animal movement to stunning [Group (GS) vs. Single-file (SFS)]. AC was defined as chilling where the average ambient temperature was -10C or lower at 1, 1.5, and 2 hours postmortem; whereas CC was defined as chilling, which did not have average temperatures lower than -8C at 1, 1.5, and 2 hours PM. Regarding animal handling, GS consisted of CO2 stunning with automated group movement of pigs into the stunner; whereas SFS consisted of electrical and CO2 stunning that required pigs to be moved to the stunner in a single-file. Data collected included carcass chilling rate, ham and loin initial pH (pHi) and ultimate pH (pHu), loin Japanese color score (JCS), and loin firmness. Carcass chilling rates were obtained using temperature trackers that allowed measurement of the temperature decline in the deep ham (semimembranosus), loin (at last rib), and shoulder (between the 2^{nd} and 3^{rd} ribs). An additional ambient probe was placed below the carcass to obtain ambient temperature during the chilling process. Data was collected on a minimum of 10 carcasses per processing plant and collected on 2 or 3 consecutive days to account for variation. Loin (last rib) and ham (semi-membranous) pH data were collected immediately prior to chilling of the carcass (pHi) and at 18 to 24 hours (pHu) PM. The pH data were collected on at least 2 days with multiple measurement sessions during the day. At least 100 measurements per pH-trait were collected at each processing plant. Similarly, loin quality data (JCS and firmness) were collected on multiple days with a minimum of 100 measurements at each processing plant. Averages from each plant were used in the meta-analysis to determine the relationship between animal handling and carcass chilling rate with meat pH, color, and firmness. Data were analyzed using ANOVA procedures in SAS using the PROC GLM procedure with main effects of chilling rate and animal handling. The experimental unit was processing facility.

Results

Initial pH in the ham and loin was improved ($P < 0.0001$) in systems with group handling of pigs prior to stunning (Table 1). Ultimate pH in the ham was not affected ($P > 0.10$) by chilling type or handling; although pHu was numerically higher in carcasses undergoing AC. Ultimate pH of the loin tended ($P = 0.12$) to increase with AC, but most of this increase was due to highest pH occurring with AC and GS (chilling x handling, $P < 0.09$). AC improved ($P < 0.06$) JCS, but GS only tended to increase JCS ($P = 0.14$). Loin firmness tended ($P = 0.18$) to improve with AC but was not affected ($P > 0.10$) by handling. As expected, chilling curves (Figure 1) were improved for AC treatments with the differences occurring from 3 to 14 h PM in the ham ($P < 0.05$), 1.5 to 10 h PM in the loin ($P < 0.05$), and 3 to 15 h PM in the shoulder ($P < 0.05$). Ambient temperatures were lower with AC from 1 to 6 h PM ($P < 0.05$).

Conclusion

This meta-analysis shows the advantages of GS and AC. The increase in pHi in GS pigs clearly indicates that stress levels are reduced when stunning systems allows for GS. However, GS must be combined with AC to reduce pH decline rate, and thus improve pHu. All measurements were collected in commercial slaughter plants with many confounding factors (i.e. feed withdrawal times, rest times, genetics, etc.) within and between slaughter plants that could minimize potentially larger effects of AC and GS on PM pH decline.

References

Berg, E. (2006). Critical points affecting fresh pork quality within the packing plant. http://porkgateway.org/resource/critical-points-affecting-fresh-pork-quality-within-the-packing-plant/

Huff-Lonergan, E. and J. Page (2012). The role of carcass chilling in the development of pork quality. http://porkgateway.org/resource/the-role-of-carcass-chilling-in-the-development-of-pork-quality/.

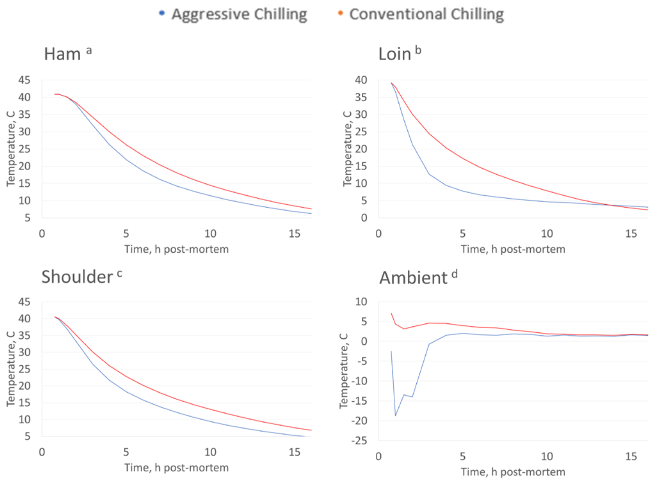
Lonergan, S. (2012). Pork Quality: pH decline and pork quality. http://porkgateway.org/resource/pork-quality-ph-decline-and-pork-quality/

Notes

	Ham		Loin			
	Initial pH	Ultimate pH	Initial pH	Ultimate pH	JCS	Firmness
AC-GS ^{c}	6.59 ± 0.05^{a}	5.80 ± 0.05^{a}	6.65 ± 0.05^{a}	5.82 ± 0.05^{a}	3.28 ± 0.10^{a}	3.05 ± 0.11^{a}
AC-SFS ^{d}	6.28 ± 0.05^{b}	5.75 ± 0.09^{a}	6.38 ± 0.05^{b}	5.65 ± 0.09^{ab}	2.95 ± 0.18^{ab}	2.70 ± 0.19^{ab}
CC-GS ^{e}	6.60 ± 0.05^{a}	5.69 ± 0.04^{a}	6.64 ± 0.05^{a}	5.62 ± 0.04^{b}	2.89 ± 0.08^{b}	2.62 ± 0.11^{b}
CC-SFS ^{f}	6.33 ± 0.05^{b}	5.71 ± 0.05^{a}	6.42 ± 0.05^{b}	5.66 ± 0.05^{b}	2.86 ± 0.09^{b}	2.73 ± 0.15^{ab}
Chilling Effect						
AC	6.43 ± 0.05	5.77 ± 0.05	6.52 ± 0.05	5.74 ± 0.05	3.11 ± 0.10	2.88 ± 0.11
CS	6.46 ± 0.03	5.70 ± 0.03	6.53 ± 0.05	5.64 ± 0.03	2.87 ± 0.06	2.68 ± 0.09
P > F	0.52	0.25	0.68	0.12	0.06	0.18
Handling Effect						
GS	6.59 ± 0.04	5.74 ± 0.03	6.64 ± 0.03	5.72 ± 0.03	3.09 ± 0.06	2.83 ± 0.08
SFS	6.30 ± 0.02	5.73 ± 0.05	6.40 ± 0.02	5.65 ± 0.05	2.90 ± 0.10	2.72 ± 0.12
P > F	0.0001	0.86	0.0001	0.27	0.14	0.43
Chilling X Handling Interaction	0.64	0.57	0.41	0.09	0.23	0.13

^{ab} Means within a column with different superscripts were significantly different ($P < 0.05$).
^{c} AC-GS = Aggressive chilling with group stunning. n = 7.
^{d} AC-SFS = Aggressive chilling with single-file stunning. n = 2.
^{e} CC-GS = Conventional chilling with group stunning. n = 10.
^{f} CC-SFS = Conventional chilling with single-file stunning. n = 7.

Table 1. Effect of Chilling Type and Handling Type on Ham and Loin Quality



^{a} The difference in chilling type was significant ($P < 0.05$) from 3 to 14 hours post-mortem. Aggressive = 9 plants and conventional = 17 plants.
^{b} The difference in chilling type was significant ($P < 0.05$) from 1.5 to 10 hours post-mortem. Aggressive = 7 plants and conventional = 10 plants.
^{c} The difference in chilling type was significant ($P < 0.05$) from 3 to 15 hours post-mortem. Aggressive = 9 plants and conventional = 17 plants.
^{d} The difference in chilling type was significant ($P < 0.05$) from 1 to 6 hours post-mortem. Aggressive = 9 plants and conventional = 17 plants.

Figure 1.
Effect of Chilling Type on Chilling Curves

Notes