PROJECT SUMMARY
PRODUCT QUALITY

BEEF
RESEARCH

Understanding the Impact of Carcass Size, Rate of Chilling, and Electrical Stimulation on Muscle Tenderness, Juiciness, and Color

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Study Completed

June 2017

This project was funded in part by the Beef Checkoff.

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Background and Objective

Growing carcass size and increased carcass mass is contributing to issues with beef tenderness, purge loss, and beef muscle color, as a result of an ever-increasing struggle for beef packers to appropriately chill beef carcasses. Specifically, large beef processing facilities are struggling to meet requirements for acceptable deep tissue (center of the round or chuck) temperatures in heavy weight carcasses prior to fabrication. With the understanding that carcass size has increased significantly during the last several decades and will continue to grow considerably moving forward, the industry must continue to investigate the effects of chilling rates and the impact of post-harvest processes (i.e. electrical stimulation) on tenderness, temperature decline, pH decline, purge loss (juiciness), and color. Therefore, this study aims to identify the relationship between carcass size, chilling rate, and electrical stimulation in an effort to ultimately make recommendations for appropriately managing the postmortem processing of today's carcasses.

Methods

Cattle producing carcasses with hot carcass weights ranging from 560 to 1100 were used in this study. Lots of cattle were evaluated for live behavior in order to understand the impacts of temperament and stress on color development and tenderness. The left or right side of each carcass was subjected to electrical stimulation protocol that is unique to each packing plant (i.e. Packing Plant A = Low Voltage ES, LVES; Packing Plant B = High Voltage ES, HVES). Carcasses were randomly assigned to fast or slow chilling protocol. To achieve two different chilling rates in each plant, half of carcasses at each collection were chilled conventionally according to the plant protocol (fast chill=FC). For the remaining carcasses, the chilling protocol was slightly altered. The alteration consisted in carcasses being held off spray for 8 to 12 hours before spray-chilled (slow chill=SC). The resulting treatment combination of electrical stimulation and chilling provided eight levels. Carcasses were monitored for temperature and pH decline as well as color development in multiple locations of the carcass (*psaos major, longissimus dorsi, and semimebranosus*). Trained sensory panels and objective measure of tenderness (shear force) were utilized to quantify changes in tenderness and juiciness.

Important Findings

Meaningful relationships were developed for chilling rate, pH decline, and color development. Additionally, the relationship between carcass surface temperature and deep tissue temperature was established. However, the present study provided no definitive evidence that electrical stimulation in combination with chilling could improve tenderness. The chilling and electrical stimulation protocols generated for this study did not demonstrate the expected advantages. However, delaying spray for six hours with no substantial adverse effects on meat palatability could reduce energy and water use. Further analysis using these data are warranted and will be pursued.

Industry Impact

These data will help the beef industry understand the impact of increasing cattle size and carcass weight on carcass chilling, palatability, and color development. The measurement of temperature and pH decline in this study are meaningful, and the relationship between the surface and deep tissue temperatures of carcasses will have meaning to the food safety aspects of producing high quality beef.

Graphs/Table

Table 5 : Effects of electrical stimulation and chilling on tenderness attributes

Variable			ES	NES[1]	P - value	FC[1]	SC	P – value
Slice Shear Force value, Kg (n=292)			3.76a	3.97b	0.013	3.92	3.8	
		SE	0.01	0.01		0.14	0.14	
Warner-Bratzler Shear force, Kg (296)			15.02	15.16	0.81	14.75	15.44	0.29
		SE	0.44	0.44		0.5	0.5	
Sensory attributes (n=300)	Initial tenderness		9.63	9.75	0.43	9.62	9.82	0.49
		SE	0.13	0.13		0.17	0.17	
	Sustained tenderness		9.55	9.76	0.17	9.51	9.8	0.21
		SE	0.14	0.14		0.16	0.17	
	Connective tissue amount		6.89	6.86	0.81	6.84	6.92	0.54
		SE	0.08	0.08		0.1	0.09	
	Initial juiciness		6.5	6.56	0.5	6.53	6.53	0.88
		SE	0.08	0.08		0.09	0.1	
	Sustained juiciness		7.7	7.66	0.68	7.68	7.68	0.94
		SE	0.09			0.11	0.11	
	Beef flavor identity		5.8	5.75	0.49	5.74	5.81	0.73
		SE	0.76	0.77		0.09	0.09	
	Brown		5.45	5.49		5.38	5.56	0.34
		SE	0.09			0.11	0.1	
	Roasted		1.27^{b}	1.13^{a}	0.02	1.18	1.22	0.53
		SE	0.05	0.05		0.05	0.05	
	Bloody/Serumy		1.81	1.79	0.66	1.82	1.78	0.7
		SE	0.04	0.04		0.05	0.05	
	Metallic		1.14	1.16	0.59	1.17	1.12	0.4
		SE	0.04			0.05	0.05	
	Umami		1.59	1.57	0.94	0.21	0.16	0.4
		SE	0.05	0				
	Liver-like		0.2	0.2	0.69	1.53	1.17	0.23
		SE	0.02	0.02		0.02	0.02	

[1] ES, electrical stimulation; NES, no electrical stimulation.
[2] FC, fast chill; SC, slow chill
[a–d] Lsmeans with different superscripts within the same row differ ($P < 0.05$).