PROJECT SUMMARY
PRODUCT QUALITY

BEEF
RESEARCH

Identifying the Influence of Post-mortem Aging Length and Method on Flavor and Tenderness of Beef Strip Loins

B. Foraker[1], D. Woerner[1], D. Gredell[1], J. Legako[2], J. Tatum[1], J. Martin[1]
R. Delmore[1], A. Heuberger[2], K. Belk[1]

[1]Colorado State University and [2]Utah State University

Study Completed

June 2017

This project was funded in part by the Beef Checkoff.

Identifying the Influence of Post-mortem Aging Length and Method on Flavor and Tenderness of Beef Strip Loins: Project Summary

Background

The most recent National Beef Quality Audit has identified flavor as the most important attribute to the consumer, so flavor research is necessary to impart a high-quality eating experience and accommodate the different preferences in flavor profiles (Igo et al., 2013). Aging has long been accepted as one practice to enhance eating characteristics of beef. Consumers generally associate aging as a positive term, regardless of their comprehension of the method (Smith et al., 2008). Methods of aging beef include dry-aging, where a humidified environment is used to impart dehydration and flavor concentration, and wet-aging, where product is stored unfrozen in a vacuum package. While many studies have targeted tenderness changes due to different aging lengths and methods, few have specifically characterized flavors and flavor compounds associated with dry and wet-aged beef and how they may change in the aging process. Furthermore, no associations have been made between flavors imparted during the aging process and compositional changes. Ultimately, the findings of this study will aid in determination of an ideal aging length and method to impart favorable flavor development for aged beef, leading to a consistent and desirable eating experience for the consumer.

Objective

The objective of this study is to identify flavors and flavor compounds associated with aged beef, evaluate the effect of different aging lengths and methods on flavor development and tenderness, and correlate chemical and compositional changes with sensory and shear force data. The objectives were met by using a trained sensory panel to characterize palatability traits, performing instrumental shear force, identifying compositional constituents, and quantitatively determining volatile flavor compounds.

Methods

Pairs of strip loins (n = 38) were collected from commodity USDA Choice beef carcasses and fabricated into a total of eight sections per carcass. Each section was randomly assigned to 1 of 8 aging treatments. Treatments consisted of six wet-age periods (3, 14, 28, 35, 49, and 63 days), one dry-age period (21 days), and a combination aging period (14 days wet-aged followed by 21 days dry-aged). Upon completion of each treatment, all sections were vacuum packaged (if not already) and placed in -20°C frozen storage. Frozen sections were fabricated into three steaks, each designated for either sensory analysis, shear force, or chemical analysis.

Steaks for sensory analysis and shear force were tempered and then cooked to a final internal temperature of 71°C. Trained panelists were used to conduct sensory analysis on flavor attributes typically associated with aged beef as well as tenderness and juiciness. Sixteen samples were fed to a minimum of 5 panelists per session for a total of 19 panels. Additionally, both slice shear force (SSF) and Warner-Bratzler shear force (WBSF) were conducted as an objective measure of tenderness.

Volatile flavor compounds were extracted from composites of each treatment and identified using gas chromatography. Fatty acids, reducing sugars, and free amino acids were extracted in a series of various assays and analyzed using gas chromatography mass spectrometry. Correlations of the flavor compounds and compositional elements were made to sensory evaluations.

Important Findings

This study showed development of off-flavor notes (metallic, sour, oxidized, nutty, musty/earthy, and liver-like) as particularly evident at wet-age lengths greater than 35 days. This came at a compromise to positive flavor notes (beef flavor ID, browned, roasted), for which ratings decreased at these extended aging periods. However, no changes in flavors, desirable or undesirable, were noted for steaks wet-aged 28 days or less. Dry-aging imparted some of the greatest ratings for beef flavor ID, browned, and roasted. The additive effect of using a combination of wet- and dry-aging resulted in nutty, musty/earthy, and sour notes relative to independent aging methods. Instrumental shear force (SSF and WBSF) showed long wet-aged steaks to be generally more tender than short wet-aged steaks. However, this tenderness improvement was seen only to a certain point within the aging process, and steaks aged longer than 28 days showed no further tenderness advantage for WBSF values. Identification of fatty acid profiles was not helpful in explaining these flavor changes, so volatile compounds should be able to explain more of these findings.

Industry Impact

With flavor becoming of more importance to the consumer, aged beef has gained popularity among high end restaurants. Consequently, consumers are willing to spend more to experience the unique flavors imparted with aged beef. This study identifies these flavors exclusive to both wet- and dry-aging methods but also the extent at which aging can be detrimental to favorable attributes. Due to yield and time loss, aging beef is no doubt an expensive process. Utilization of these findings can allow establishments to maximize their efforts in developing an ideal aging protocol for their operation to satisfy the needs of their customers.

References

Igo, J. L., D. L. VanOverbeke, D. R. Woerner, J. D. Tatum, D. L. Pendell, L. L. Vedral, G. G. Mafi, M. C. Moore, R. O. McKeith, G. D. Gray, D. B. Griffin, D. S. Hale, J. W. Savell, and K. E. Belk. 2013. Phase I of The National Beef Quality Audit-2011: Quantifying willingness-to-pay, best-worst scaling, and current status of quality characteristics in different beef industry marketing sectors. J. Animal Scence 91:1907-1919

Smith, R. D., K. L. Nicholson, J. D. W. Nicholson, K. B. Harris, R. K. Miller, D. B. Griffin, & J. W. Savell. (2008). Dry versus wet-aging of beef: Retail cutting yields and consumer palatability evaluations of steaks from US choice and US select short loins. Meat Science, 79(4), 631-639.

Graphs/Tables

Table 1. Trained sensory ratings[1] for flavor attributes, slice shear force (SSF) values, Warner-Bratzler shear force (WBSF) values, and cook loss of beef longissimus steaks representing eight aging treatments.

	Wet-age (days)						Dry-age (days)	Combination[2]	SEM[3]	*P* - Value
Attribute	3	14	28	35	49	63	21			
Beef Flavor ID	7.46^{ab}	7.43^{ab}	7.46^{ab}	7.28^{b}	6.75^{c}	6.53^{c}	7.54^{a}	7.33^{ab}	0.13	<0.01
Browned	4.65^{a}	4.46^{ab}	4.55^{ab}	4.40^{bc}	4.19^{cd}	4.15^{d}	4.64^{a}	4.62^{a}	0.13	<0.01
Roasted	5.03^{cd}	5.08^{bc}	5.19^{bc}	5.13^{bc}	4.81^{e}	4.86^{de}	5.45^{a}	5.26^{ab}	0.12	<0.01
Metallic	1.80^{bc}	1.73^{c}	1.69^{c}	1.80^{bc}	1.92^{ab}	2.00^{a}	1.84^{abc}	1.79^{bc}	0.09	0.01
Fat-Like	1.56	1.67	1.62	1.63	1.54	1.51	1.57	1.56	0.07	0.29
Sour	1.46^{cd}	1.37^{d}	1.57^{cd}	1.70^{c}	2.61^{a}	2.84^{a}	1.68^{c}	2.00^{b}	0.11	<0.01
Oxidized	0.32^{bc}	0.23^{c}	0.28^{c}	0.43^{b}	0.61^{a}	0.68^{a}	0.34^{bc}	0.31^{bc}	0.05	<0.01
Nutty	0.54^{c}	0.58^{c}	0.54^{c}	0.61^{c}	1.17^{a}	1.06^{a}	0.55^{c}	0.78^{b}	0.08	<0.01
Musty/Earthy	0.61^{e}	0.58^{e}	0.73^{de}	1.01^{cd}	2.07^{b}	2.37^{a}	0.68^{e}	1.28^{c}	0.13	<0.01
Liver-Like	0.25^{cd}	0.16^{d}	0.26^{cd}	0.28^{cd}	0.63^{a}	0.64^{a}	0.33^{bc}	0.43^{b}	0.06	<0.01
Overall Tenderness	8.76	8.90	8.85	9.15	8.75	8.90	8.79	8.91	0.15	0.48
Initial Juiciness	5.51	5.83	5.59	5.83	5.81	5.69	5.70	5.66	0.13	0.18
Sustained Juiciness	5.60	5.85	5.67	5.78	5.83	5.73	5.67	5.61	0.14	0.58
SSF (kg)	14.63^{a}	13.14^{b}	12.06^{c}	11.50^{cd}	11.49^{cd}	10.96^{d}	11.38^{cd}	11.36^{cd}	0.41	<0.01
WBSF (kg)	3.57^{a}	3.28^{b}	2.75^{de}	2.72^{de}	2.64^{e}	2.62^{e}	3.08^{bc}	2.89^{cd}	0.09	<0.01
Cook Loss (%)	25.00^{a}	24.26^{a}	24.44^{a}	22.33^{b}	22.31^{b}	23.47^{ab}	18.61^{c}	17.28^{c}	0.65	<0.01

[a-e] Least square means in the same row lacking a common superscript differ ($P < 0.05$)
[1]Attributes were scored using a 15 point hedonic scale: 0 = very tough, very dry, and not present; 15 = very tender, very juicy, and very intense
[2]Wet-age period of 14 days followed by dry-age period of 21 days
[3]Standard error (largest) of the least squares means

BeefResearch.org
303.694.0305
For more information, contact:
National Cattlemen's Beef Association • Contractor to the Beef Checkoff Program
9110 East Nichols Avenue • Centennial, CO 80112 • 303.694.0305
BEEF
Funded by Beef Farmers & Ranchers