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Evaluating the Effect of Accelerated Aging at Different Temperature and Time Points on Beef Quality and Enzyme Activity of Lower Quality Beef Cuts

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Abstract

The objective of this study was to explore the effects of different time and temperature accelerated aging (AA) treatments on beef tenderness, yield, microbial quantity, and enzyme activity on lower quality beef cuts. The shoulder clod and top round muscles were collected from 10 U.S. Department of Agriculture choice beef carcasses, fabricated into steaks, and assigned to one of six treatments: 3 days postmortem (control), cooler aged for 21 days, AA 120°F for 2 h, AA 120°F for 3 h, AA 130°F for 2 h, and AA 130°F for 3 h. Yield calculation, aerobic plate counts, instrumental tenderness, cathepsin enzyme activity, and collagen analysis were performed. All AA treatments effectively decreased microbial loads on the steak surface and in purge ($P < 0.05$). The AA steaks exhibited lower yield compared to the cooler aged steaks or control ($P < 0.01$). All AA treatments improved tenderness of the samples compared to the control ($P < 0.01$) with most exhibiting similar tenderness as the 21-day cooler aged treatment. The amount of collagen present in the purge was greater in AA samples compared to the cooler aged samples ($P < 0.01$). Finally, it was interesting to point out that AA 120°F at 3 h seem to stimulate the most cathepsin enzyme activity among the treatments in beef ($P < 0.01$).

Introduction

As the prices for beef products continue to rise, consumers search for alternatives to the middle meat beef cuts. These lower priced cuts are often less tender than the middle meat, so there is a continued effort for the meat industry to develop technologies to increase the palatability of these "lower quality" beef cuts. A new tenderization method known as accelerated aging (AA) encompasses incubating vacuum packaged beef in a warm water bath to stimulate native enzymatic activity in beef and subsequently increase the rate of the tenderization process. To our knowledge, there is no research on the impact of AA on beef quality. Therefore, this study aimed to explore the effects of four AA methods at different temperature and time points on meat quality and enzymatic activity of two lower quality beef cuts.

Experimental Procedures

Shoulder clod and top round were collected from 10 U.S. Department of Agriculture choice beef carcasses, and each cut was fabricated into steaks and assigned to one of six treatments: 3 days postmortem (control), cooler aged for 21 days, AA 120°F for 2 h, AA 120°F for 3 h, AA 130°F for 2 h, and AA 130°F for 3 h. Yield was calculated based on loss during AA treatment and cooking loss. Warner-Bratzler shear force (WBSF) was measured for each sample, and the purge for microbial analysis was collected from each primal bag as well as from each vacuum package after the AA treatment. The purge for collagen analysis was collected from all six treatments. The steak surface was swabbed on the anterior side prior to AA treatments and swabbed on the posterior side after the AA treatments. Aerobic plate counts (APC) were performed on the purge and swab samples. Cathepsin activity was determined through zymography. Soluble collagen content and total collagen in the purge was determined through hydroxyproline content.

Results and Discussion

As expected, all AA treatments decreased APC on steak surfaces ($P < 0.01$; Figure 1) and in the purge ($P < 0.05$; Table 1). After AA, the 130°F samples had a lower yield than the 120°F groups ($P < 0.05$; Table 1). The cooler aged samples had a lower cook yield than all of the AA samples ($P < 0.01$; Table 2), and shoulder clod displayed higher cooking yield than the top round muscle ($P < 0.01$; Table 1). On the other hand, the WBSF results showed that AA 120°F for 3 h samples and both AA 130°F samples displayed similar tenderness to the samples that were cooler aged for 21 days ($P < 0.01$; Table 2). The amount of collagen in the purge was highest in the shoulder clod ($P < 0.01$; Table 1), and all of the AA treatments had higher collagen in the purge than the control or cooler aged samples ($P < 0.01$; Table 2). The amount of soluble collagen was highest in the AA 130°F samples compared to the other treatments in the shoulder clod, while no difference was found for soluble collagen among treatments in the top round ($P < 0.01$; Table 1). Interestingly, there were three distinct bands in the cathepsin zymography data, which likely indicated that the tenderness improvement in beef samples was the result of a synergistic effect of multiple cathepsin enzymes. In general, the zymography data indicated there was heightened enzymatic activity during all of the treatments when compared to the control samples, and all 3 bands demonstrated that the AA at 120°F for 3 h treatment displayed the highest activity compared to other AA treatments ($P < 0.01$; Table 2).

Implications

Accelerated aging has shown to be a promising technique to increase value in lower price beef cuts through increasing enzymatic activity as well as tenderness without accelerating the growth of microorganisms. However, the accelerated aging process may also increase moisture loss during treatment. By thoroughly understanding the process of accelerated aging, the beef industry may be able to add value to lower-priced beef cuts in a speedy, convenient, and economical manner.

Acknowledgments

The Kansas Beef Council.

Table 1. Effects of six different accelerated aging (AA) treatments on band 3 of cathepsin zymography, collagen content in purge, cook yield, soluble collagen content, treatment yield, and microbial loads in purge on two different muscles

		Muscle			
Items	Treatment	Shoulder clod	Top round	SEM[1]	*P*-value
Cathepsin enzyme band 3		2.72[a]	2.23[b]	0.46	<0.05
Total collagen in purge (%)		0.05[a]	0.04[b]	0.002	<0.01
Cook yield (%)		80.08[a]	78.23[b]	0.29	<0.01
Soluble collagen (%)				0.04	<0.01
	Cooler aged 2 d	0.16[Ca]	0.07[Aa]		
	Cooler aged 21 d	0.12[Ca]	0.07[Aa]		
	AA 120°F for 2 h	0.13[Ca]	0.09[Aa]		
	AA 120°F for 3 h	0.11[Ca]	0.08[Aa]		
	AA 130°F for 2 h	0.38[Aa]	0.07[Ab]		
	AA 130°F for 3 h	0.26[Ba]	0.10[Ab]		
Treatment yield (%)				0.38	<0.05
	AA 120°F for 2 h	95.2[Aa]	90.59[Ab]		
	AA 120°F for 3 h	94.79[Aa]	91.4[Ab]		
	AA 130°F for 2 h	91.47[Ba]	89.07[Bb]		
	AA 130°F for 3 h	90.73[Ba]	87.14[Cb]		
Purge (log CFU/oz)				8.84	<0.05
	Before treatment	79.2[Aa]	27.6[Ab]		
	AA 120°F for 2 h	0.19[Ba]	0.17[Ba]		
	AA 120°F for 3 h	0.08[Ba]	0.19[Ba]		
	AA 130°F for 2 h	0.19[Ba]	0.07[Ba]		
	AA 130°F for 3 h	0.39[Ba]	0.07[Ba]		

[A-C]Values within a column of an item, with different superscripts differ significantly at $P < 0.05$.
[a-b]Values within a row with different superscripts differ significantly at $P < 0.05$.
[1]SEM = Standard error of the mean.

Table 2. Main effect of six different accelerated aging (AA) treatments on cathepsin activity, total collagen in purge, Warner-Bratzler shear force (WBSF) and cook yield (n = 120)

	Treatment							
Item	Cooler aged 3 days	Cooler aged 21 days	AA 120°F 2 h	AA 120°F 3 h	AA 130°F 2 h	AA 130°F 3 h	SEM[1]	*P*-value
Total collagen in purge (%)	0.03^{d}	0.03^{d}	0.04^{c}	0.04^{c}	0.05^{b}	0.07^{a}	0.003	<0.01
WBSF (lb)	9.8^{a}	8.5^{cd}	9.2^{b}	8.9^{bc}	8.5^{cd}	8.2^{d}	0.26	<0.01
Cook yield (%)	76.47^{c}	77.52^{c}	79.19^{b}	79.64^{b}	80.36^{ab}	81.76^{a}	0.5	<0.01
Cathepsin enzyme activity								
Band 1	1.33^{b}	1.28^{b}	2^{a}	1.95^{a}	1.45^{b}	1.27^{b}	0.3	<0.01
Band 2	1.09^{bc}	1.07^{bc}	1.23^{ab}	1.46^{a}	1.15^{bc}	0.91^{c}	0.25	<0.01
Band 3	1.41^{c}	2.58^{ab}	2.26^{b}	3.19^{a}	2.77^{ab}	2.63^{ab}	0.46	<0.01

[a-d]Values within a row with different superscripts differ significantly at $P < 0.05$.
[1]SEM = Standard error of the mean.

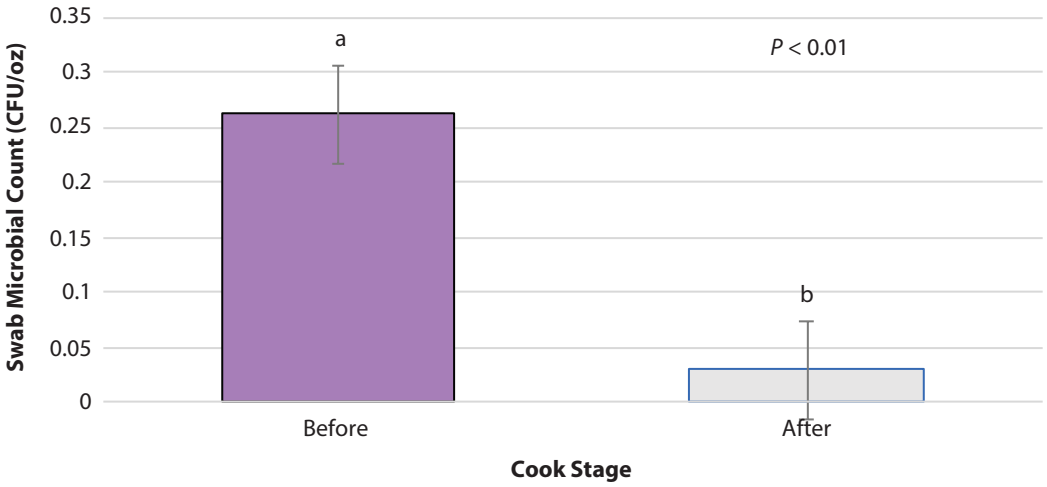

Figure 1. Main effect of cooking stage on six different treatments in microbial swabs (n = 80).