EVALUATING THE EFFECT OF ACCELERATED AGING AT DIFFERENT TEMPERATURE AND TIME POINTS ON YIELD, SENSORY AND SHELF-STABILITY ON LOWER QUALITY BEEF CUTS

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I. INTRODUCTION

Due to the recent price increase of beef, consumers are constantly in search for cheaper alternatives to the expensive middle meat. However, beef cuts that are marketed at a lower value tend to have higher content of connective tissue and are more tough. Accelerated aging (AA) of meat is a relatively new concept, which places vacuum-packaged beef in a warm water bath for a few hours to enhance the enzymatic activity of cathepsin, which research has demonstrated its ability to weaken the connective tissue in beef. However, other than knowing AA can improve beef tenderness, there is little research on the impact of AA on other meat quality parameters. Therefore, the objective of this study was to evaluate the effect AA at different temperatures and time points has on the growth of microorganisms, color, yield, sensory characteristics, proximate analysis, and lipid oxidation of lower quality beef cuts.

II. MATERIALS AND METHODS

Ten USDA choice beef carcasses were selected, and the shoulder clod and top round were collected from both sides of the carcass. The triceps brachii (TB) and semimembranosus (SM) were fabricated from the subprimals at 3 days postmortem then cut into 2.54 cm steaks. Each muscle was subjected to one of six treatments: 1) 3 d postmortem (control); 2) 21 d aging; 3) AA 49°C for 2 h; 4) AA 49°C for 3 h; 5) AA 54°C for 2 h; 6) AA 54°C for 3 h. The AA treatments were applied through 10 sous vide systems. Steak surfaces were swabbed and purge was collected before and after AA for aerobic plate counts (APCs). A total of 20 trained sensory panels were conducted to evaluate initial juiciness, sustained juiciness, myofibrillar tenderness, connective tissue amount, overall tenderness, beef flavor intensity, and off-flavor. Color measurements of L*, a*, and b* values were taken from steaks designated for biochemical analysis. Finally, proximate analysis (fat, moisture, protein) and lipid oxidation were analyzed. Data was analyzed using the GLIMMIX procedure of SAS as a split-plot where the whole plot is the muscle and the sub plot as the AA treatment applied.

III. RESULTS AND DISCUSSION

All 4 AA treatments produced lower APC for the swabs from the steak surface and the purge compared to the control and the 21 d aged samples ($P<0.01$). The AA temperatures used in the experiment are considered to be within the "danger zone" with regards to food safety to where predictive models at similar temperature and time points estimate lower likelihood of reducing bacterial counts. However, this experiment showed that AA at both 49 and 54 °C were effective in reducing microbial loads. The trained panelists rated AA samples to have lower sustained juiciness ($P<0.01$). The ratings for both myofibrillar and overall tenderness were greatest for the cooler aged for 21 d samples, followed by AA 54°C for 3 h, with the rest all rated to have similar degree of tenderness ($P<0.01$). Both AA 54°C for 3 h and cooler aged for 21 d samples had lower connective tissue content ratings compared to the rest of the treatments ($P<0.01$). Beef flavor intensity decreased in the AA 54°C samples compared to the control ($P<0.05$). Overall, the sensory data highlights a sense of moisture loss in AA samples, particularly for the AA 54°C ones, which the low juiciness ratings mirror the moisture data to where all AA treatments decreased the moisture ($P<0.05$) and increased in lipids and protein content ($P<0.01$). In regards to color, the cooler aged for 21 d and AA 54°C for 3 h samples have the lowest a* values regardless of muscle types, while the AA 49°C for 2 h samples had similar a* value as the control ($P<0.01$). Finally, lipid oxidation increased in all AA samples as expected ($P<0.01$).

Table 1. Effect of accelerated aging on APC of the purge, L*, a*, b*, yield, moisture, lipid oxidation, and sensory panel ratings.

Measurements	Muscle	Treatment						SEM[1]	P-value
		Cooler Aged 3 d	Cooler Aged 21 d	AA 49°C 2 hrs	AA 49°C 3 hrs	AA 54°C 2 hrs	AA 54°C 3 hrs		
Main Effects									
Lipid Oxidation (mg MDA/kg)		0.25^{c}	0.28^{c}	0.5^{b}	0.44^{b}	0.51^{b}	0.67^{a}	0.07	< 0.01
Sensory Panel[2]									
Sustained Juiciness		41.47^{b}	49.73^{a}	34.28^{c}	35.71^{c}	34.21^{c}	32.59^{c}	1.83	< 0.01
Myofibrillar Tenderness		51.69^{c}	63.64^{a}	50.7^{c}	50.69^{c}	53.52^{c}	57.95^{b}	2.07	< 0.01
Connective Tissue		26.6^{ab}	16.68^{c}	27.13^{a}	23.58^{ab}	22.88^{b}	17.06^{c}	2.12	< 0.01
Overall Tenderness		43.99^{c}	58.06^{a}	41.38^{c}	42.85^{c}	46.49^{c}	51.84^{b}	2.41	< 0.01
Beef Flavor		32.55^{a}	31.68^{ab}	32.69^{a}	31.09^{ab}	29.91^{b}	29.59^{b}	1.04	< 0.05
Interactions	Muscle								
L*									
	TB	38.12^{Ac}	39.75^{Ac}	47.82^{Aa}	48.07^{Aa}	46.13^{Aa}	42.45^{Ab}	0.90	<0.05
	SM	38.12^{Ad}	41.49^{Acd}	46.89^{Aa}	44.42^{Bb}	43.41^{Bbc}	41.59^{Ac}		
a*									
	TB	16.82^{Bab}	15.36^{Ab}	17.57^{Aa}	15.76^{Aab}	12.82^{Ac}	11.5^{Ac}	0.71	<0.01
	SM	19.18^{Aa}	11.43^{Bc}	17.48^{Aa}	15.43^{Ab}	14.61^{Ab}	12.39^{Ac}		
Moisture (%)									
	TB	72.97^{Aa}	72.22^{Aa}	70.16^{Abc}	69.86^{Abc}	69.19^{Ac}	69.49^{Ac}	0.46	<0.05
	SM	71.97^{Aa}	72.44^{Aa}	69.61^{Abc}	70.63^{Ab}	69.61^{Abc}	67.82^{Bd}		
After AA Yield (%)									
	TB	N/A	N/A	95.20^{Aa}	94.79^{Aa}	91.47^{Ab}	90.73^{Ab}	0.38	<0.01
	SM	N/A	N/A	90.59^{Ba}	91.40^{Ba}	89.07^{Bb}	87.14^{Bc}		
Microbial Purge APC (log CFU/mL)									
	TB	3.16^{Aa}	N/A	1.03^{Ab}	0.7^{Ab}	0.96^{Ab}	1.04^{Ab}	0.14	<0.01
	SM	2.82^{Ba}	N/A	0.95^{Ab}	1.07^{Ab}	0.80^{Ab}	0.80^{Ab}		

$^{A-B}$Least square means without a common superscript differ within the column

$^{a-d}$Least square means without a common superscript differ across the row

[1]Standard error of the least square means

[2]Sensory scores: 0=extremely dry/tough/bland or none; 50=neither dry nor juicy/neither tough nor tender/neither bland nor intense/moderate amount; 100=extremely juicy/tender/abundant/intense

IV. CONCLUSION

This study indicated that AA increased the microbial safety and tenderness, but decreased other sensory characteristics such as juiciness, beef flavor intensity and shelf stability for the lower quality beef cuts. AA has shown to be a promising technique for use in the industry to quickly improve beef tenderness, but further works are needed to establish proper cooking techniques such as cooking to lower degree of doneness or the use of sauces to make up for the loss of moisture.

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