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ARTICLE

Effects of Aging and Aging Method on Physicochemical and Sensory Traits of Different Beef Cuts

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Abstract Wet and dry aging methods were applied to improve the quality of three different beef cuts (butt, rump, and sirloin) from Hanwoo cows (quality grade 2, approximately 50-mon-old). After 28 d of wet aging (vacuum packaged; temperature, 2±1°C) and dry aging (air velocity, 2–7 m/s; temperature, 1±1°C; humidity, 85±10%), proximate composition, cooking loss, water holding capacity, shear force, color, nucleotides content, and sensory properties were compared with a non-aged control (2 d postmortem). Both wet and dry aging significantly increased the water holding capacity of the butt cuts. Dry aging in all beef cuts induced lower cooking loss than that in wet-aged cuts. Shear force of all beef cuts was decreased after both wet and dry aging and CIE L*, a*, and b* color values in butt and sirloin cuts were higher in both wet and dry aging ($p<0.05$) groups than those in the non-aged control. Regardless of the aging method used, inosine-5′-monophosphate content among beef cuts was the same. The sensory panel scored significantly higher values in tenderness, flavor, and overall acceptability for dry-aged beef regardless of the beef cuts tested compared to non- and wet-aged cuts. In addition, dry-aged beef resulted in similar overall acceptability among the different beef cuts, whereas that in wet-aged meat was significantly different by different beef cuts. In conclusion, both wet and dry aging improved the quality of different beef cuts; however, dry aging was more suitable for improving the quality of less preferred beef cuts.

Keywords wet aging, dry aging, beef cuts, aging method

Introduction

Tenderness, flavor, and juiciness are important factors for consumers to determine the acceptability and palatability of beef (Piao et al., 2018). The beef industry retails the beef cuts on the middle side of the carcass such as the loin to satisfy the palatability of consumers for tender, flavorful, and juicy beef (Kukowski et al., 2004). This preference

for middle cuts of beef has resulted in lower utilization of the end cuts such as the round and intensified retail price differences between preferred and non-preferred beef cuts (Kukowski et al., 2005). Lepper-Blilie et al. (2014) reported that value-added cuts had the potential to replace ribeye steak at a lower cost. However, they also mentioned that further education and research is required for consumers. Reed et al. (2017) reported that injecting pork subcutaneous fat to low-quality beef decreased the Warner-Bratzler shear force values and improved consumer sensory palatability, however, this also produced an undesirable pork flavor.

The aging process is used for the improvement in the eating quality of fresh meat such as tenderness, flavor, and/or juiciness (Kim and Kim, 2017). The process is divided into two types, wet and dry aging (Lee et al., 2017). In wet aging, the fresh beef is stored at refrigerated temperature (below 5°C) under vacuum packaging and generally leads to a sourer and stronger bloody/serumy flavor than that of dry-aged beef (Laster et al., 2008). Furthermore, during wet aging, the degradation of nucleotides is accompanied by decomposition into inosine 5'-monophosphate (IMP) and further accumulation of hypoxanthine, inosine, and ribose, which contribute to the umami taste and the bitter taste of meat (Aaslyng and Meinert, 2017). In general, beef is dry aged under controlled airflow, temperature, and relative humidity without packaging and it creates more intense beefy and brown/roasted flavor than that of wet-aged beef (Laster et al., 2008). Previous studies have reported that the application of dry aging in low-marbled beef improved the tenderness and sensory properties (Lee et al., 2017; Lepper-Blilie et al., 2016). According to previous studies, during both wet and dry aging, the meat tenderness is improved by proteolysis of the myofibrillar protein and degradation of structural proteins, and the meat flavor is developed by changing the concentration of peptides and free amino acids (Aaslyng and Meinert, 2017; Laville et al., 2009). Both wet and dry aging have been shown to enhance the eating quality of beef by different processes (Kim et al., 2017).

The hypothesis of the present study was that the quality difference between preferred and non-preferred beef cuts could be overcome by the aging process. Therefore, the objective of the study was to investigate the effect of aging and aging method (wet and dry aging) on the quality properties of different beef cuts (sirloin, butt, and rump).

Materials and Methods

Sample preparation

Eight Hanwoo cows (approximately 50-mon-old) were slaughtered at a local slaughterhouse (Anseong, Korea) and graded as quality grade 2 according to the Korean carcass grading system (KAPE, 2018). Then, a total of 16 butts, rumps, and sirloins were collected. Eight samples of the three beef cuts (butt, rump, and sirloin) from one side of each carcass were vacuum packaged, and immediately frozen at –70°C at 2 d postmortem to use as the control. Eight samples of the three beef cuts from the other side of each carcass (n=4 for each treatment) were aged for 28 d under different aging methods as follows: i) wet aging: each sample was vacuum packaged in oxygen impermeable nylon bags (2 mL $O_2 \cdot (m^2)^{-1} \cdot 24\ h^{-1}$ at 0°C, 0.09 mm thickness; Sunkyung Co. Ltd., Korea), and stored at 2±1°C, and ii) dry aging: each sample was stored under controlled conditions (air velocity, 2–7 m/s; temperature, 1±1°C; humidity, 85±10% in a specialized facility with thermohygrometer and anemometer at Korea Institute for Animal Products Quality Evaluation). After aging, the dried surfaces (crust) of all dry-aged samples were trimmed off, and the beef samples were vacuum packaged and frozen at –70°C for physicochemical and sensory analyses.

Proximate composition

The meat samples were ground and 250 g of the ground meat was placed into a sample cup and put in the FoodScan Lab

meat analyzer (FoodScan™ Lab meat, FOSS, Hillerød, Denmark). The proximate composition (moisture, fat, protein, and collagen) was determined following the method of the Association of Official Analytical Chemists (2016).

pH

Each meat sample (1 g) was homogenized with 9 mL of distilled water using a homogenizer (T10 basic, Ika, Staufen, Germany). The homogenates were centrifuged (Continent 512R, Hanil Co., Ltd., Daejeon, Korea) at 2,265×g for 10 min and filtered (Whatman No. 4, Whatman PLC., Kent, UK). The pH value of each filtrate was measured using a pH meter (SevenGo, Mettler-Toledo International Inc., Greifensee, Switzerland), which was pre-calibrated using standard buffers (pH 4.01, 7.00, and 9.21).

Cooking loss

Cooking loss was determined as the percentage weight loss of each meat sample after cooking. Meat samples (30 g) were vacuum packaged (HFV-600L, Hankook Fujee Co., Ltd., Hwaseong, Korea), heated in a water bath at 90℃ for 15 min until a core temperature of 72℃ was reached, and cooled in ice water (Oh et al., 2017). After recording the final weight, cooking loss was calculated as expressed below:

$$\text{Cooking loss (\%)} = \frac{\text{Weight before cooking} - \text{Weight after cooking}}{\text{Weight before cooking}} \times 100$$

Water holding capacity

Each meat sample (5 g) was placed into a centrifugation tube with a filter paper (Whatman No. 4, Whatman PLC, UK), and centrifuged at 2,265×g for 10 min. After centrifugation, the water holding capacity was calculated as the remaining moisture in the meat sample based on the moisture content of the original meat sample using the following equation:

$$\text{Water holding capacity (\%)} = \frac{(A - B) \times 100}{A}$$

$$\text{where } A = (\text{Weight before centrifuge (g)} \times \text{Moisture (\%)})/100$$

$$B = (\text{Weight before centrifuge} - \text{Weight after centrifuge})$$

Warner-Bratzler shear force

The vacuum packaged meat samples (30 g) were heated in a water bath at 72℃ for 40 min and cooled in ice water. The cooked sample was cut into a 10×10×30 mm sized block to measure the shear force. Six blocks were obtained from each cooked sample. The value was measured using a Warner-Bratzler shear attachment on a texture analyzer (LC 500N, AMETEK Lloyd Instruments Ltd., Bognor Regis, UK) with the following parameters: maximum cell load 10 kg, target load 10 g, target value 25 mm, and target speed 2.0 mm/s. The samples were sheared perpendicularly to the direction of the muscle fiber.

Meat color

The color of the meat samples was measured after packaging had been opened and then samples were bloomed for 30 min at room temperature. A chroma meter (CR410, Konica Minolta Co., Osaka, Japan) was used and CIE L*, a*, and b* values

were measured from three different locations in the samples and the average value was used.

Nucleotides content

The meat samples (3 g) were mixed with 20 mL of 0.6 M perchloric acid and homogenized for 30 s at 1,130×g to extract nucleic acids. The extracted nucleic acids were then centrifuged for 15 min at 2,265×g (Continent 512R, Hanil Co., Ltd., Korea) and filtered through a filter paper (Whatman No. 1, Whatman PLC., UK). The supernatant was then adjusted to pH 5.5 with 6N KOH. The pH-adjusted supernatant was placed in a volumetric flask and the volume adjusted to 50 mL with 0.6 M perchloric acid (pH 5.5). After cooling for 30 min, the supernatant was filtered through a 0.2 μm poly vinylidene fluoride syringe filter (HSW norm-ject, Whatman PLC, UK). The filtrate (1.5 mL) was analyzed using high-performance liquid chromatography (Ultimate 3000, Dionex, Dreieich, Germany) under the following analytical conditions: column (250×4.6 mm^2, 4 μm particles; Synergi Hydro-RP, Phenomenex Inc., Seoul, Korea); injection volume 10 μL; mobile phase, 20 mM potassium phosphate (pH 5.5) and 60% methanol in deionized distilled water; flow rate and time, 1.0 mL/min for 25 min. The column temperature was maintained at 30°C and the detection was monitored at a wavelength of 254 nm. The peaks of the individual nucleotides were identified using the retention times for standards hypoxanthine, inosine, IMP, and adenosine-5′-monophosphate (AMP; Sigma Chemical Co., USA) and the concentration was calculated using the area of each peak.

Sensory evaluation

The sensory quality of samples was evaluated by an untrained consumer panel (30 sensory panelists) using the three beef cuts after wet and dry aging compared to non-aged beef (control). Each sample was cut into similar size pieces (50×20×6 mm) and roasted on each side using an electrical tin plate grill with water jacket (ca. 250±5°C) until the core temperature reached 72°C. The scoring of each sample was performed on a single sheet using a 7-point hedonic scale (1=extremely dislike to 7=extremely like). The sensory evaluation was performed on four traits: juiciness, tenderness, flavor, and overall acceptability.

Statistical analysis

A randomized incomplete block design was applied, using the trial as the block. The non-aged butt, rump, and sirloin (control, n=8 per trial, total 16 for 2 trials) and 2 different aging methods (n=4 per trial, total 8 for 2 trials of butt, rump, and sirloin) were assigned, and the model was analyzed with a fixed effect (wet and dry aging method with different beef cuts) and random effect (carcass and side of the carcass). Calculations based on the general linear model were performed using the SAS 9.3 software program (SAS Institute Inc., USA) and the results were reported as mean values with standard error of the means (SEM). Significant differences among the mean values were determined by the Student-Newman-Keuls multiple comparison test at a level of $p<0.05$.

Results and Discussion

Proximate composition

Changes in the chemical composition of beef samples depended on the aging method and beef cuts used except for the collagen content (Table 1). For the moisture content, dry aging induced significant reduction in all beef cuts except for the rump compared to non-aged and wet-aged cuts. Wet aging resulted in no significant change to moisture content of rump and sirloin compared to the non-aged counterpart, whereas dry aging reduced the moisture content of butt and sirloin by

Table 1. Effect of different aging methods on proximate composition of different beef cuts

Traits (%)	Beef cuts	Non-aged	Aging method		SEM
			Wet	Dry	
Moisture	Butt	70.71^{ax}	67.78^{by}	65.29^{cy}	0.812
	Rump	69.85^{x}	70.98^{x}	69.99^{x}	0.549
	Sirloin	67.13^{ay}	65.84^{ay}	63.81^{by}	0.678
	SEM	0.393	0.861	0.917	
Fat	Butt	5.99^{by}	7.90^{by}	10.02^{ax}	0.722
	Rump	6.59^{y}	5.08^{z}	5.48^{y}	0.711
	Sirloin	9.90^{bx}	11.29^{abx}	12.82^{ax}	0.726
	SEM	0.484	0.843	0.982	
Protein	Butt	21.46^{b}	22.50^{ax}	22.88^{a}	0.251
	Rump	21.67^{b}	22.08^{abx}	22.80^{a}	0.294
	Sirloin	21.18	20.95^{y}	21.73	0.306
	SEM	0.184	0.351	0.331	
Collagen	Butt	1.84	1.83	1.81	0.098
	Rump	1.88	1.86	1.73	0.094
	Sirloin	1.79	1.93	1.65	0.095
	SEM	0.051	0.119	0.116	

SEM, standard error of the means (n=24).
$^{a–c}$ Values with different letters within the same row differ significantly ($p<0.05$).
$^{x–z}$ Values with different letters within the same column differ significantly ($p<0.05$).

evaporation of water, which is in agreement with previous results (Ba et al., 2014; Lee et al., 2017). For the fat content, non- and wet-aged sirloin cuts showed the highest values and dry-aged rump cuts had the lowest value ($p<0.05$). In a previous study, a negative correlation between fat and moisture content of beef was shown after wet aging (Cho et al., 2010). The wet-aged sirloin showed lower protein content than that of the other groups ($p<0.05$). The protein content of the butt and rump was higher ($p<0.05$) after dry aging possibly due to the evaporation of moisture. The protein contents were not different among beef cuts after dry aging ($p>0.05$).

Physicochemical traits

The pH was not influenced by the aging method and beef cuts ($p>0.05$, Table 2). Cooking loss indicates that the water loss from the meat occurred from protein denaturation during cooking (Aaslyng et al., 2003). Dry aging showed significantly lower cooking loss in beef cuts than that of the non- and wet-aged cuts. The cooking loss in sirloin was lower than that of the other beef cuts regardless of the aging method used ($p<0.05$, Table 2). Laster et al. (2008) and Rhee et al. (2004) also reported different cooking losses among beef muscles. Oh et al. (2017) reported that dry aging reduced the cooking loss in cow and steer *longissimus lumborum* muscle. Furthermore, wet aging did not increase cooking loss (Hughes et al., 2014; Oh et al., 2017). In the present study, both wet and dry aging methods did not affect the water holding capacity of beef cuts except for the butt ($p>0.05$). Non-aged beef cuts showed different water holding capacities, however, the wet- and dry-aged beef cuts showed no difference among beef cuts.

Table 2. **Physicochemical trait changes of different beef cuts during wet or dry aging**

Traits	Beef cuts	Non-aged	Aging method		SEM
			Wet	Dry	
pH	Butt	5.53	5.57	5.63	0.036
	Rump	5.52	5.54	5.52	0.017
	Sirloin	5.50	5.60	5.57	0.035
	SEM	0.024	0.020	0.045	
Cooking loss (%)	Butt	28.82^{ay}	28.73^{ay}	24.22^{bx}	0.886
	Rump	32.83^{ax}	32.22^{ax}	27.04^{bx}	0.736
	Sirloin	27.66^{az}	26.77^{az}	19.89^{by}	0.986
	SEM	0.336	0.649	1.240	
Water holding capacity (%)	Butt	65.26^{by}	70.12^{ab}	75.42^{a}	2.280
	Rump	66.14^{y}	70.17	69.90	1.725
	Sirloin	71.52^{x}	72.97	73.55	2.552
	SEM	1.656	2.603	2.476	
Shear force	Butt	70.81^{a}	38.79^{b}	46.97^{b}	5.879
	Rump	70.58^{a}	48.01^{b}	46.60^{b}	6.489
	Sirloin	63.26^{a}	36.48^{b}	37.26^{b}	4.721
	SEM	5.662	4.106	4.269	

SEM, standard error of the means (n=24).
^{a,b} Values with different letters within the same row differ significantly ($p<0.05$).
$^{x–z}$ Values with different letters within the same column differ significantly ($p<0.05$).

Regardless of the aging method, there was no significant difference in the shear force among beef cuts. For each beef cut, both wet and dry aging processes led to reduction in shear force ($p<0.05$). Meat is tenderized by proteolytic enzymes, which degrade myofibrillar and cytoskeletal proteins that weaken the muscle structure and increase tenderness during wet and dry aging (Kim et al., 2017; Oh et al., 2017).

Meat color

Wet aging increased the L* value of the butt and sirloin but not the rump; however, dry aging increased the L* value of the three different beef cuts (Table 3). In a previous study, dry-aged beef showed lower L* values due to moisture evaporation, which causes lower reflection of light (Dikeman et al., 2013). However, the aged beef in the present study showed a brighter color than that of the non-aged beef, which might be due to the enzymatic changes in myofibrillar proteins, resulting in different absorption, transmission, and reflection characteristics of the meat surface (Gasperlin et al., 2001). Three different beef cuts had significantly different L* value before and after wet aging (Table 3). However, dry aging minimized the difference and resulted in the similar L* value, regardless of different beef cuts.

Both wet and dry aging processes increased the a* and b* values of each beef cut except for rump ($p<0.05$). The a* and b* values of the rump were not significantly affected by aging or the aging method. Color stability can be affected by muscle types, which have different oxygen consumption rates and metmyoglobin reductase activities (Kim et al., 2017). In the present study, color change was dependent on aging method.

Table 3. Effect of different aging methods on instrumental color (L*, a*, and b*) of different beef cuts

Traits	Beef cuts	Non-aged	Aging method		SEM
			Wet	Dry	
CIE L*	Butt	33.80^{by}	38.30^{ax}	37.92^{a}	0.526
	Rump	35.62^{bx}	36.06^{by}	38.18^{a}	0.615
	Sirloin	35.68^{bx}	38.91^{ax}	39.15^{a}	0.708
	SEM	0.534	0.503	0.657	
CIE a*	Butt	19.66^{b}	23.65^{a}	22.70^{a}	0.547
	Rump	20.10	21.59	21.53	0.719
	Sirloin	19.08^{b}	22.15^{a}	21.08^{a}	0.625
	SEM	0.428	0.746	0.706	
CIE b*	Butt	7.09^{b}	9.97^{a}	10.14^{a}	0.418
	Rump	7.51	8.35	8.89	0.517
	Sirloin	6.77^{b}	9.27^{a}	8.81^{a}	0.521
	SEM	0.306	0.563	0.536	

SEM, standard error of the means (n=24).
^{a,b} Values with different letters within the same row differ significantly ($p<0.05$).
^{x,y} Values with different letters within the same column differ significantly ($p<0.05$).

Nucleotides content

Nucleotides play a role as flavor precursors in meat via the interaction of free amino acids. IMP is the major flavor enhancer related to the umami taste and hypoxanthine produces the bitter taste in meat (Kavitha and Modi, 2007; Oh et al., 2017). The change in nucleotides content of each beef cut during wet and dry aging is shown in Table 4. The AMP content of beef cuts was not affected by the aging method. The non-aged beef rump showed the highest AMP content among the three beef cuts. However, after wet and dry aging, differences in AMP content among the different cuts were not observed. Previous studies have reported that AMP content was different based on age of the animal, gender, quality grade, and beef cuts (Oh et al., 2017; Piao et al., 2017). Both aging methods significantly reduced the IMP content of each beef cut ($p<0.05$). Thus, IMP was continuously dephosphorylated to inosine during aging (Tikk et al., 2006). Regardless of aging and the aging method used, IMP contents were not significantly different among beef cuts.

Both aging methods increased the inosine content of sirloin but did not affect those in the butt and rump. Similar to the AMP content of non-aged beef cuts, inosine content in the non-aged rump was the highest among the beef cuts. The highest inosine content was found in sirloin after dry aging, which might be caused by the difference in enzyme activity among beef cuts such as nucleoside phosphorylase that converts inosine to hypoxanthine (Watanabe et al., 1989). The content of hypoxanthine in wet- and dry-aged beef cuts was significantly increased ($p<0.05$). However, the hypoxanthine content in the butt was higher than the other beef cuts both before and after wet aging. After dry aging, the hypoxanthine content in the butt and rump were not significantly different. The dry-aged sirloin showed the lowest hypoxanthine content among the beef cuts, which might be related to the inosine content and nucleoside phosphorylase activity.

Sensory evaluation

In the present study, both wet and dry aging led to improvement in sensory traits but this was dependent on beef cuts

Table 4. Effects of different aging methods on nucleotides content of different beef cuts

Traits	Beef cuts	Non-aged	Aging method		SEM
			Wet	Dry	
AMP	Butt	1.02^{y}	1.61	1.53	0.200
	Rump	1.66^{x}	1.62	2.00	0.183
	Sirloin	1.30^{xy}	1.04	1.36	0.224
	SEM	0.166	0.198	0.225	
IMP	Butt	151.50^{a}	51.30^{c}	73.11^{b}	5.996
	Rump	156.84^{a}	59.33^{b}	64.26^{b}	5.366
	Sirloin	147.03^{a}	58.67^{b}	67.67^{b}	5.409
	SEM	4.372	5.290	5.924	
Inosine	Butt	22.44^{xy}	22.67	22.98^{y}	1.375
	Rump	23.97^{x}	25.32	24.33^{xy}	1.290
	Sirloin	20.41^{by}	25.47^{ab}	27.60^{ax}	1.910
	SEM	0.953	2.467	1.153	
Hypoxanthine	Butt	18.55^{bx}	47.89^{ax}	44.54^{ax}	1.252
	Rump	15.00^{by}	41.37^{ay}	40.68^{ax}	0.976
	Sirloin	15.07^{cy}	38.60^{ay}	33.90^{by}	1.166
	SEM	0.581	1.406	1.771	

SEM, standard error of the means (n=24).
$^{a-c}$ Values with different letters within the same row differ significantly ($p<0.05$).
^{x,y} Values with different letters within the same column differ significantly ($p<0.05$).

(Table 5). Lepper-Blilie et al. (2016) reported that two different aging methods (dry or wet) did not affect the sensory panel evaluating the juiciness of low marbled beef loin. Laster et al. (2008) also reported that the juiciness of ribeye, strip loin, and top sirloin scored by the sensory panel were not affected by either wet or dry aging. Similar to a previous study (Laster et al., 2008), the sensory panel in the present study did not score the juiciness of sirloin differently based on the aging method, whereas the panel found differences in the juiciness of the butt and rump by the aging method. The panel detected significant differences in juiciness and overall acceptability among the beef cuts between non-aged and wet-aged beef cuts. After dry aging, however, there was no significant difference in juiciness among the beef cuts.

The sensory panel indicated higher scores for the tenderness of wet-aged and dry-aged butt and rump than that of non-aged butt and rump; however, sirloin showed no difference regardless of aging or aging method. This result did not agree with the shear force result. Wezemael et al. (2014) reported that approximately 30% of consumer panels scored beef tenderness incorrectly compared to the shear force result. In addition, this tendency was different depending on the beef muscles being analyzed. After dry aging, the tenderness among the beef cuts was similar ($p<0.05$).

The sensory panel did not detect any difference in flavor among beef cuts for non-aged and wet-aged beef. After dry aging, the flavor in the butt and sirloin significantly increased. Dry-aged beef has a beefy and roasted flavor, whereas wet-aged beef has a bloody and metallic flavor (Khan et al., 2016). Consumer panelists in the present study might prefer the specific flavor obtained from dry aging. The result of the overall acceptability was significantly different among non-aged and wet-aged beef cuts, whereas no difference was found among the beef cuts after dry aging. After dry aging, panel did not evaluate the sensory

Table 5. **Effect of different aging methods on sensory evaluation of different beef cuts**

Traits	Beef cuts	Non-aged	Aging method		SEM
			Wet	Dry	
Juiciness	Butt	2.72^{by}	3.32^{aby}	4.09^{a}	0.288
	Rump	3.22^{aby}	2.63^{bz}	3.86^{a}	0.237
	Sirloin	4.46^{x}	4.05^{x}	4.20	0.184
	SEM	0.301	0.195	0.211	
Tenderness	Butt	2.57^{b}	3.57^{axy}	4.19^{a}	0.202
	Rump	3.11^{b}	3.06^{by}	4.02^{a}	0.206
	Sirloin	3.52	4.08^{x}	4.38	0.246
	SEM	0.256	0.219	0.174	
Flavor	Butt	3.25^{b}	3.56^{ab}	4.19^{ax}	0.231
	Rump	3.14	3.01	3.56^{y}	0.161
	Sirloin	3.61^{b}	3.84^{b}	4.43^{ax}	0.165
	SEM	0.183	0.215	0.164	
Overall acceptability	Butt	2.57^{cy}	3.28^{by}	4.08^{a}	0.220
	Rump	2.82^{y}	3.06^{y}	3.79	0.246
	Sirloin	3.69^{bx}	3.98^{abx}	4.34^{a}	0.143
	SEM	0.205	0.192	0.225	

SEM, standard error of the means (n=12).
$^{a–c}$ Values with different letters within the same row differ significantly ($p<0.05$).
$^{x–z}$ Values with different letters within the same column differ significantly ($p<0.05$).

evaluation traits among beef cuts differently except for flavor while after wet aging, panel only evaluated flavor among beef cuts not differently. Therefore, dry aging was a more appropriate method to improve non-preferred beef cuts than wet aging.

Conclusion

Both wet and dry aging changed the quality traits in different beef cuts. Dry aging improved the quality of the butt and rump cuts, which were less preferred than the sirloin cut owing to tenderness and flavor. Similar sensory scores for tenderness, juiciness, and overall acceptance were chosen by the panel for the butt and rump compared to those of the sirloin. Therefore, dry aging is a more suitable method for improving quality properties of less preferred beef cuts such as the butt and rump.

Conflict of Interest

The authors have declared that there is no potential confilct of interest.

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Author Contributions

Conceptualization: Yoon Y, Jo C. Data curation: Kim M, Choe J. Formal analysis: Yoon Y, Yoon S. Methodology: Lee HJ, Yoon Y. Validation: Choe J, Yoon S. Writing - original draft: Kim M, Lee HJ. Writing - review & editing: Kim M, Choe J, Lee HJ, Yoon Y, Yoon S, Jo C.

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