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Physicochemical and microbial characteristics of *longissimus lumborum* and *biceps femoris* muscles in Korean native black goat with wet-aging time

Mahabbat Ali[1,2], Ji-Young Park[1], Seong-Yun Lee[1], Young-Sun Choi[3] and Ki-Chang Nam[1]*

[1]*Department of Animal Science and Technology, Sunchon National University, Suncheon 57922, Korea*
[2]*Department of Animal Production and Management, Sher-e-Bangla Agricultural University, Dhaka 1207, Bangladesh*
[3]*Jeollanamdo Agricultural Research and Extension Services, Gangjin 59213, Korea*

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***Corresponding author**
Ki-Chang Nam
Department of Animal Science and Technology, Sunchon National University, Suncheon 57922, Korea.
Tel: +82-61-750-3231
E-mail: kichang@scnu.kr

ORCID
Mahabbat Ali
https://orcid.org/0000-0002-5332-7758
Ji-Young Park
https://orcid.org/0000-0001-9680-8685
Seong-Yun Lee
https://orcid.org/0000-0003-1361-1962
Young-Sun Choi
https://orcid.org/0000-0002-6843-7423
Ki-Chang Nam
https://orcid.org/0000-0002-2432-3045

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Abstract

This study examined the effects of different wet-aging times on the physicochemical characteristics and microbial profile of *longissimus lumborum* (LL) and *biceps femoris* (BF) muscles from Korean native black goat (KNBG) meat. The water holding capacity (WHC), pH, cooking loss, shear force, meat color, free amino acid, total bacteria, and coliform count of KNGB meat were analyzed at 0, 5, 10, and 15 days of wet-aging at 4℃ under vacuum packaging. The results showed that different wet-aging times led to significant pH variations between the muscles throughout the aging period. The wet-aging time did not affect the WHC and cooking loss in meat from the LL muscle. In the BF muscle, however, meat wet-aged for five days had a significantly higher WHC and less cooking loss than meat aged for 0, 10, and 15 days. The meat from the LL muscle wet-aged for five days produced tenderer meat (low shear force value) than the unaged meat ($p < 0.05$). Moreover, the color was similar in the LL muscle regardless of the number of aging days. In the BF muscle, the redness (a*) was higher in the meat wet-aged for 15 days compared to that aged for 0, 5, and 10 days ($p < 0.05$). Regardless of the muscles, an increase in wet-aging time led to an increase in the total free amino acids contents in both muscles ($p < 0.05$). On the other hand, the tasty/bitter amino acid ratio was significantly higher for five days of wet-aged meat than 10 and 15 days of aging from the BF muscle. In addition, regardless of the muscles, the total bacteria and coliform counts were significantly lower for five days of wet-aged meat than 10 and 15 days of aging ($p < 0.05$). Therefore, chevon wet-aged for five days is an optimal aging period under vacuum packaging that fortifies meat quality with a minimal microbial negative defect.

Keywords: Korean native black goat, Goat muscles, Wet-aging, Chevon quality to this article was reported.

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Availability of data and material
Upon reasonable request, the datasets of this study can be available from the corresponding author.

Authors' contributions
Conceptualization: Nam KC.
Methodology: Ali M,
Validation: Park JY, Lee SY, Choi YS.
Investigation: Ali M, Choi YS.
Writing- original draft: Ali M.
Writing - review and editing: Ali M, Park JY, Lee SY, Choi YS, Nam KC.

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INTRODUCTION

Aging is a process to preserve the meat and increase the flavor and tenderness under a controlled environment [1]. In addition, it involves the substantial improvement of the meat qualities, such as tenderness, juiciness, as well as flavor through the biochemical breakdown of muscle by endogenous proteases [2]. Aging improves the tenderness and palatability but decreases the meat color with increasing aging period [3]. Meat tenderness is an excellent quality parameter to the consumers, which is incorporated with the aging period [4]. The tenderness of meat varies according to the muscle types and connective tissues that are attached to the muscle. Therefore, different aging periods are needed to achieve optimal aging conditions according to the consumer's satisfaction [5].

Owing to less subcutaneous and higher visceral fat, chevon is considered leaner than mutton and beef [6]. Of these, the Korean native black goat (*Capra hircus coreanae*, KNBG) is a typical native goat breed comprising more than 80% of the whole goat population in South Korea. The meat is consumed as a health-promoting food, especially for pregnant women, and for medicinal purposes for curing ulcer healing or stomach inflammation [7]. Goat meat (chevon) is a recognized source of lean meat in the human diet compared to other meats with positive dietary values [1]. Although goat meat is highly nutritious, it can be an extremely perishable food item owing to its relatively poor hygienic slaughtering and process conditions. Therefore, goat meat is consumed mainly in soups or extracts [7].

Wet-aging improves the tenderness of meat as a part of the proteolytic degradation of the myofibrillar protein and increases the flavor of aged meat because of the changing sequence of peptides and amino acids [8,9]. It also increases the eating quality of meat at different storage times and processes [10]. On the other hand, the taste, flavor, texture, and other physicochemical characteristics of aged-meat varies according to the different meat cuts because of the different contents of collagen, free amino acids, fatty acids, and nucleotides [11]. Many studies have examined the effects of wet-aging time and packaging on different beef cuts focusing on the exposure of air [12,13]. The present study hypothesized that aged meat from the Korean black goat could be preferred over unaged meat in the form of muscle cuts with market eligibility. Hence, it is expected that the physicochemical characteristics and microbial load of *longissimus lumborum* (LL) and *biceps femoris* (BF) muscles will be affected by different wet-aging times in goat meat. On the other hand, the effects of the wet-aging time with vacuum packaging of chevon from the loin LL, and hind leg (BF), muscles have not been investigated thoroughly owing to their physicochemical characteristics and microbial aspects. Therefore, this study examined the effects of the wet-aging time with vacuum packaging conditions at 4℃ on the pH, water-holding capacity, cooking loss, shear force, free amino acids, and microbial profile of the LL and BF muscles in KNBG meat.

MATERIALS AND METHODS

Animals and sample preparation for laboratory analysis

Twenty-one KNBG (castrated male) were reared under the same diet and farming conditions at Gangjin Jeollanamdo farm and slaughtered at 16 mon of age. After exsanguination, evisceration, and carcass dressing, eight separate cuts from the loin (LL) and hind leg (BF) were collected randomly and wet-aged with vacuum packaging at 4℃ for 0, 5, 10, and 15 days respectively. The meat quality characteristics, free amino acid concentration, and microbial load of the wet-aged chevon of the LL and BF muscles from the KNBG meat were analyzed after 0, 5, 10, and 15 days of aging periodically.

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Water holding capacity, pH, and cooking loss

With the slightly modified method described elsewhere [14], 5 g of the minced meat sample from each treatment was centrifuged at 4℃ for 10 min at 1,000 rpm with a centrifuge machine (Combi 514-R, HANIL, Korea), and the water holding capacity (WHC) was measured. The pH of the samples from two different muscles was measured by blending 2 g of the meat samples with 18 mL of distilled water followed by homogenization at 15,000 rpm for 30 s using a homogenizer (Polytron PT 10-35 GT, Kinematica, Luzern, Switzerland). After filtration, the homogenized fillet samples with filter paper pH values were measured using a pH meter (Seven Excellence^{TM}, Mettler Toledo, Worthington, OH, USA) at room temperature. The measurements were performed in triplicate. The cooking loss for each muscle from the KNBG meat was determined as the percentage weight loss after cooking in an electric grill with double pans (Nova EMG-533, 1,400 W, Evergreen enterprise, Yongin, Korea) for 60 s until to reach the internal temperature of the meat sample at 72℃ with the standardized of cuts sample (30×50×10 mm).

Meat color and Warner-Bratzler shear force

The lightness (L*), redness (a*), and yellowness (b*) of the LL and BF muscles from the KNBG meat were measured using a colorimeter (CR-410, Minolta, Osaka, Japan). The measurements were performed in triplicate. The shear force values of the LL and BF muscles (cooked meat sample) were measured in a cubic form (30 × 50 × 10 mm). Subsequently, they were cut perpendicular to the longitudinal orientation of the muscle fiber using a Warner-Bratzler shear attachment on a texture analyzer (TA-XT2, Stable Micro System, Surrey, UK). The maximum shear force value (kg·f) was taken for each sample. The test and pre-test speeds were set to 2.0 mm/s, and post-test speeds were set to 5.0 mm/s.

Free amino acids analysis

The free amino acid concentrations were determined using minor modifications of the methodology described elsewhere [15]. After removing the externally visible fat from the fillet, a 3 g aliquot of the samples from each muscle was mixed with 27 mL of a 2% trichloroacetic acid (TCA) solution. The sample with a solution was then homogenized for 1 min at 13,500 rpm. Subsequently, the homogenate was again centrifuged at 17,000×g for 15 min and filtered through a 0.45 μM membrane filter. High-performance liquid chromatography (HPLC) analysis of the free amino acids was performed using the following conditions: an S433, auto analyzer, Cation separation column (LCAK07/li), 4.6 × 150 mm; buffer change (A: pH 2.90, B: pH 4.20, C: pH 8.00); (Lithium citrate buffer solution), buffer flow rate: 0.45 mL/min, Ninhydrin flow rate: 0.25 mL/min, Column temp.: 37℃.

Microbial analysis

The total bacteria and coliform were counted. A 3 g sample was diluted with 27 mL of 0.85% NaCl and homogenized at 13,500 rpm for 1 min. Subsequently, 1 mL of the mixture was plated to a film culture medium using an Aerobic Count Plate & Coliform Count Plate (3M Petrifilm, 3M, St. Paul, MN, USA). The plates were incubated at 37℃ for 24 h, and the total bacteria and coliform were counted by multiplying the number of red colonies observed in each plate.

Statistical analysis

The data were analyzed statistically using the general linear model with [16] while applied the Student-Newman-Keuls test as a multiple assay technique to test the significance ($p < 0.05$). The result is displayed as the SEM and the processing interval.

RESULTS AND DISCUSSION

Quality characteristics (pH, water holding capacity, and cooking loss)

Table 1 lists the effects of wet-aging time on the meat quality characteristics of the LL and BF muscles from KNGB meat. The results showed that meat from the BF muscle had a significantly higher pH than LL muscle after 0, 5, and 10 days of aging. Depending on the muscle types, the BF muscle is composed of type I (oxidative muscle), which produces less lactate during the metabolic cycle of a muscle contraction, resulting in a higher pH [17]. In LL muscle, however, the pH of the meat wet-aged for 15 days was significantly higher than those aged for other periods, which was beyond the normal range and already underwent a putrefaction state might be attributed to microbial proliferation in this study. Moreover, the muscle temperature and fiber types influence the pH of the meat while evaluating the meat quality attributes [18]. The wet-aging time had a similar effect on the LL muscle and BF in terms of WHC, which concurred with a previous study [11]. On the other hand, in the BF muscle, meat for five days had a significantly higher WHC compared to the meat wet-aged for 0, 10, and 15 days. Five days of aging leads to the discharge of divalent cations that obstruct the myofibrillar proteins due to the electrostatic effect, precluding the formation of salt bridges among the myofibrils. As a result, improved moisture holding in meat is achieved by muscle fiber enlargement (swelling) caused by enriched electrostatic repulsions [19].

Aging also influences water retention in the muscle because of the degradation of the cytoskeletal protein that removes the leakage of water within the muscle during aging on different muscles with different fibers [20]. Cooking loss is caused by protein denaturation during different aging processes assessed in many studies [21]. Wet-aging did not affect the cooking loss of the LL muscle as the number of wet-aging days increased. In a comparison of two muscles, the meat from BF muscle wet-aged for five days showed lower cooking loss ($p < 0.05$) than that of the LL muscle because of the higher water-holding capacity, which could be considered a marker for the completion of aging for goat meat aged in this study. On the other hand, a variation of cooking loss between the muscles showed that cooking loss depends on the animal species, animal age, types of muscle, amount of collagen, and orientation of muscle collagen in meat [22].

Meat color

The meat color is the first appraisal for consumer satisfaction. Table 2 lists the color of wet-aged

Table 1. Effects of wet-aging time on meat quality characteristics of LL and BF muscles from KNBG meat

Item	Treatment	Days of aging				SEM (n=8)
		0	5	10	15	
Ultimate pH	LL	5.91^{by}	5.88^{by}	5.96^{by}	6.21^{ax}	0.03
	BF	6.08^{ax}	6.07^{ax}	6.04^{ax}	5.93^{by}	0.01
	SEM	0.04	0.02	0.01	0.01	
WHC (%)	LL	87.35	86.35^{y}	87.95	89.95	2.64
	BF	79.65^{c}	94.80^{ax}	89.35^{b}	89.40^{b}	0.79
	SEM	3.54	0.70	1.21	0.81	
Cooking loss (%)	LL	8.13	9.31^{x}	6.49	8.94	0.98
	BF	9.87^{a}	6.19^{by}	9.52^{a}	9.95^{a}	0.49
	SEM	0.43	0.66	1.20	0.56	

a–c Mean values with different letters within the same row differ significantly ($p < 0.05$).

x,y Mean values with different letters within the same column differ significantly ($p < 0.05$).

LL, *longissimus lumborum*; BF, *biceps femoris*; KNBG, Korean native black goat.

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Table 2. Effects of wet-aging time on meat color and shear force of LL and BF muscles from KNBG meat

Color	Treatment	Days of aging				SEM (n=8)
		0	5	10	15	
CIE L*	LL	38.67	38.07	38.14^{x}	36.70	0.53
	BF	37.81^{a}	37.84^{a}	36.8^{aby}	36.13^{b}	0.33
	SEM	0.49	0.34	0.20	0.63	
CIE a*	LL	22.52	20.46	21.68	20.48^{y}	1.08
	BF	19.75^{b}	21.28^{b}	20.02^{b}	25.03^{ax}	0.63
	SEM	1.40	0.73	0.70	0.42	
CIE b*	LL	11.19	9.86	9.57^{x}	9.80^{b}	0.78
	BF	10.39^{a}	9.00^{b}	7.10^{cy}	11.07^{aa}	0.42
	SEM	1.05	0.50	0.39	0.20	
Shear force (kg.f)	LL	5.29^{a}	2.16^{by}	2.23^{by}	3.19^{by}	0.28
	BF	4.92	3.58^{x}	4.17^{x}	4.03^{x}	0.38
	SEM	0.47	0.15	0.29	0.20	

$^{a–c}$Mean values with different letters within the same row differ significantly (p < 0.05).

^{x,y}Mean values with different letters within the same column differ significantly (p < 0.05).

LL, *longissimus lumborum*; BF, *biceps femoris*; KNBG, Korean native black goat.

meat for the different aging times between two major muscles (LL and BF) from KNBG. In the LL muscle, the aging time had no significant effects on the meat color as the number of days increased. In contrast, a significantly lower lightness (L*) was observed at 15 days of aging in BF muscle, which might be due to the low pH. Wet-aging leads to lighter meat with increasing aging time, as reported by [23], and the mechanism involved in the lightness is myoglobin oxidation [24]. A higher myoglobin content in muscle contributes to a lower lightness. Therefore, the disparity of lightness in LL might be due to a lack of oxygen (the oxidizing effect is eliminated) in muscle as aging was performed under vacuum conditions [25], which would result in higher myoglobin contents. In addition, the redness in the BF muscle increased after 15 days of wet-aging compared to 0, 5, and 10 days, which was used as a parameter for assessing meat oxidation related to the oxidation of myoglobin (deoxymyoglobin or oxymyoglobin) to metmyoglobin [26]. The redness of goat meat decreased with aging [25], but the inconsistency of the result from this study regarding BF muscle is likely due to the vacuum packaging. Moreover, the color stability of meat can be influenced by muscle types, having different oxygen consumption rates, and metmyoglobin reductase activities [27]. Regarding the muscle types, the overall color stability was higher in the LL muscle than in the BF muscle regardless of the aging time because of the higher metmyoglobin reducing activity in the LL muscle than in the BF muscle [28].

Warner-Bratzler shear force

Table 2 lists the Warner-Bratzler shear force values of the LL and BF muscles from KNBG. Aging influences tenderness due to complex transformations in muscle metabolism [29]. The wet-aging time had a significant effect on muscle cuts after different aging times. Wet-aged BF muscle showed a significantly higher shear force than the LL muscle, possibly because it contains more collagen in BF muscle [30]. Regardless of the aging time, aged meats from LL muscle tended to show significantly lower shear force values than unaged meat (p < 0.05). In a comparison of muscles, LL muscle wet-aged for five days had a lower shear force than BF muscle (p < 0.05), indicating tenderer meat in different aging lines. Therefore, wet-aging for five days results in more activation of proteolytic enzymes in meat with more activation of μ-calpains than losses of the cytoskeletal integrity of the muscle. In BF muscle, the wet-aging time did not show any significant difference throughout the entire aging time ($p > 0.05$), possibly due to less desmin degradation, which is related to fewer improvements at aging [31]. Furthermore, wet-aging at different aging times resulted in tenderer meat than unaged meat because of the activities of proteolytic enzymes that degrade the responsible protein (myofibrillar and cytoskeletal protein), which deteriorates the muscle structure and increases the tenderness of meat at aging [27].

Free amino acids

Table 3 lists the free amino acid compositions (tasty) of LL and BF muscles procured from KNBG wet-aged meat. Table 4 lists the bitter amino acids for both muscles. Increasing values for free amino acids were detected in both goat muscles as the number of days of aging increased because of the association of proteolysis [32]. In both muscles, an increase in the total free amino acids contents (Table 5) increased with the increasing number of aging days [33].

BF had a significantly higher content of total free amino acids after 15 days of wet-aging in the

Table 3. Effects of wet-aging time on tasty free amino acids (mg/100 g) concentration of LL and BF muscles from KNBG meat

FAA	Treatment	Days of aging				SEM (n=8)
		0	5	10	15	
Taurine (functional)	LL	790.37	764.44^{y}	760.28^{y}	777.65^{y}	58.42
	BF	910.46^{c}	970.36^{bx}	1,041.70^{ax}	987.40^{bx}	9.16
	SEM	48.80	37.72	39.17	40.70	
Aspartic acid (umami)	LL	119.78^{x}	120.48	130.63	137.86	7.20
	BF	106.19^{by}	102.34^{b}	148.93^{a}	156.52^{a}	9.03
	SEM	1.32	10.78	6.64	10.25	
Glutamic acid (umami)	LL	484.94	268.16	332.77	258.51	90.49
	BF	479.80^{a}	301.96^{b}	317.48^{b}	297.83^{b}	14.49
	SEM	89.25	66.95	47.26	46.00	
Glycine (very sweet)	LL	240.41^{cx}	292.87^{by}	291.45^{by}	504.55^{ax}	8.12
	BF	213.17^{cy}	347.12^{bx}	336.87^{bx}	374.28^{ay}	4.02
	SEM	6.12	3.06	9.08	5.91	
Alanine (sweet)	LL	460.45^{cy}	580.44^{bx}	650.87^{ay}	678.39^{ay}	19.00
	BF	542.08^{cx}	502.30^{dy}	813.41^{ax}	756.72^{bx}	11.76
	SEM	18.70	18.93	14.33	9.23	
Asparagine (tasty)	LL	30.55^{c}	76.02^{bc}	105.15^{by}	257.13^{a}	14.26
	BF	24.78^{c}	121.07^{b}	138.56^{bx}	276.65^{a}	9.78
	SEM	8.39	16.82	7.28	13.86	
Threonine (tasty)	LL	21.60^{c}	47.27^{bc}	69.18^{b}	130.82^{a}	10.76
	BF	20.19^{d}	51.79^{c}	77.48^{b}	135.41^{a}	3.03
	SEM	2.16	3.05	6.34	13.99	
Serine (very sweet)	LL	35.18^{c}	85.46^{bc}	115.96^{b}	215.19^{a}	16.32
	BF	31.77^{d}	94.41^{c}	142.02^{b}	230.45^{a}	7.33
	SEM	3.16	7.73	11.43	20.98	
Lysine (salty)	LL	27.45^{by}	51.49^{by}	82.79^{b}	160.00^{a}	13.77
	BF	52.55^{cx}	66.78^{cx}	92.15^{b}	161.14^{a}	4.53
	SEM	4.03	3.03	8.09	18.14	

$^{a–d}$Mean values with different letters within the same row differ significantly ($p < 0.05$).

^{x,y}Mean values with different letters within the same column differ significantly ($p < 0.05$).

LL, *longissimus lumborum*; BF; *biceps femoris*; KNBG, Korean native black goat; FAA, free amino acid.

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Table 4. Effects of wet-aging time on bitter free amino acids (mg/100 g) concentration of LL and BF muscles from KNBG meat

FAA	Treatment	Days of aging				SEM (n=8)
		0	5	10	15	
Valine (bitter)	LL	42.08[cx]	62.77[bc]	90.09[ab]	116.45[a]	11.58
	BF	23.60[dy]	55.33[z]	95.21[b]	150.86[a]	3.75
	SEM	2.86	7.02	9.91	11.85	
Methionine (bitter)	LL	16.39[b]	46.78[ab]	59.58[a]	73.56[a]	9.92
	BF	12.84[z]	23.84[z]	65.35[b]	92.50[a]	4.41
	SEM	1.07	6.67	8.45	10.90	
Isoleucine (very bitter)	LL	24.75[b]	38.48[b]	53.67[b]	87.48[a]	9.46
	BF	17.32[d]	31.83[z]	57.90[b]	104.06[a]	1.67
	SEM	4.87	3.25	5.08	11.16	
Leucine (bitter)	LL	37.36[b]	107.28[aab]	142.00[a]	197.54[a]	23.17
	BF	38.55[d]	68.38[bz]	146.78[b]	234.40[a]	4.30
	SEM	6.49	9.80	12.55	28.56	
Arginine (bitter)	LL	15.65	36.82	578.65	162.00	269.66
	BF	31.51	14.78	63.32	162.10	45.60
	SEM	6.62	9.13	377.86	81.78	
Phenylalanine (bitter)	LL	20.93[bx]	47.56[ab]	69.99[a]	82.87[a]	9.94
	BF	12.94[dy]	31.93[z]	73.21[b]	99.98[a]	4.27
	SEM	0.91	4.64	10.41	10.18	
Histidine (bitter)	LL	18.57[z]	39.96[bx]	41.67[by]	62.42[a]	3.79
	BF	19.73	30.57[y]	55.02[x]	64.56	1.53
	SEM	1.67	1.34	1.70	5.10	

[a–d]Mean values with different letters within the same row differ significantly ($p < 0.05$).

[x–z]Mean values with different letters within the same column differ significantly ($p < 0.05$).

LL, *longissimus lumborum*; BF, *biceps femoris*; KNBG, Korean native black goat; FFA, free amino acid.

Table 5. Effects of wet-aging time on total FAA, tasty, bitter, and tasty/bitter FAA (mg/100 g) concentration of LL and BF muscles from KNBG meat

Item	Treatment	Days of aging				SEM (n=8)
		0	5	10	15	
∑FAA	LL	2,991.01[c]	3,354.45[bc]	4,259.86[ab]	4,708.50[a]	286.74
	BF	3,071.75[c]	3,399.61[c]	4,377.79[b]	5,235.82[a]	125.48
	SEM	134.10	85.94	372.10	179.17	
∑Tasty FAA	LL	1,278.99[b]	1,354.44[b]	1,578.99[by]	2,073.76[a]	102.86
	BF	1,344.14[c]	1,434.27[c]	1,840.50[bx]	2,097.08[a]	36.86
	SEM	112.99	86.90	51.90	29.74	
∑Bitter FAA	LL	175.60	379.65	1,035.65	782.28	264.68
	BF	156.49[c]	256.67[c]	556.8[b]	908.47[a]	48.68
	SEM	7.74	33.61	367.73	91.90	
∑Tasty/∑bitter FAA	LL	7.36[a]	3.78[b]	2.46[b]	2.73[b]	0.90
	BF	8.62[a]	5.59[b]	3.34[c]	2.36[d]	0.22
	SEM	0.80	0.62	0.76	0.29	

[a–d]Mean values with different letters within the same row differ significantly ($p < 0.05$).

[x,y]Mean values with different letters within the same column differ significantly ($p < 0.05$).

FAA, free amino acids; LL, *longissimus lumborum*; BF, *biceps femoris*; KNBG, Korean native black goat.

entire aging period (p < 0.05). The aging time led to more umami, tasty, and overall total amino acids onwards of aging time with a high degree of protein degradation regarding a longer aging period [13]. Proteolysis included the breakdown of myofibrillar protein in muscle, which causes the release of peptides and amino acids that are responsible for the taste and flavor characteristics [33]. Furthermore, both unaged muscles had a significantly higher ratio of tasty and bitter amino acids than other aging periods (Table 5). Wet-aged meat from 5 days in the LL muscle had a significantly lower tasty and bitter amino acid ratio than the unaged or 0-day wet-aged meat. Furthermore, BF muscle produced a significantly lower ratio of tasty and bitter amino acids than the unaged as well as the 10 and 15-day wet-aged meat. On the other hand, some free amino acids decreased or remained constant during the aging process due to an increase in mold strain [34]. Therefore, wet-aging enhances the tasty amino acids for both muscles. In contrast, BF aged muscle exhibited higher taurine contents (functional free amino acid) than the LL muscle, making it attractive to health-conscious consumers.

Microbial analysis

Table 6 lists the microbial load of LL and BF muscles from KNBG meat with different wet-aging periods. Regardless of the muscles, meat wet-aged for five days had a significantly lower count on the total bacterial load than 0, 10, and 15 days of aging. Consequently, the meat wet-aged for five days had significantly lower coliform counts than meat from both muscles wet-aged for 10 and 15 days. The lower bacterial and coliform count for the meat wet-aged for five days might be due to the effects of vacuum packaging initially after the aging process. The bacterial population in the meat wet-aged for five days is safer according to the EU regulation No. 2073/2005, which states that up to 5 Log (CFU/cm^2) or 5 Log (CFU/g) is acceptable for meat consumers. In addition to the microbial count, more than 7 Log (CFU/cm^2) or 7 log (CFU/g) cannot be consumed as safe in food [35]. The results suggest that the wet-aging of vacuum packaging at low temperatures reduces moisture evaporation and inhibits microbial growth. Moreover, meat wet-aged for up to 10 days is safer in terms of microbial spoilage.

CONCLUSION

Data from the current study confirmed that the wet-aging time enhances the meat quality attributes, particularly tenderness and amino acid content, and reduces the microbial load compared to unaged meat. Moreover, wet-aged meat from BF muscle harbored higher WHC and redness as the number of days wet-aged increased. In contrast, the aging time did not adversely affect

Table 6. Effects of wet-aging time on microbial count (Log CFU/g) of LL and BF muscles from KNBG meat

Item	Treatment	Days of aging				SEM (n=8)
		0	5	10	15	
Total bacteria	LL	5.29^{cx}	3.72^{dx}	5.94^{b}	6.96^{ay}	0.05
	BF	4.19^{cy}	3.28^{dy}	5.79^{b}	7.24^{ax}	0.08
	SEM	0.08	0.05	0.05	0.05	
Coliform	LL	2.51^{d}	3.30^{cx}	5.28^{bx}	6.40^{ax}	0.07
	BF	2.50^{c}	2.28^{cy}	4.15^{by}	5.12^{ay}	0.12
	SEM	0.14	0.09	0.05	0.02	

$^{a–d}$Mean values with different letters within the same row differ significantly (p < 0.05).

^{x,y}Mean values with different letters within the same column differ significantly (p < 0.05).

LL, *longissimus lumborum*; BF, *biceps femoris*; KNBG, Korean native black goat.

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the overall color stability. Regarding the muscles, BF contained a higher free amino acid content, WHC, and redness compared to LL muscle for all aging times, suggesting that BF muscle or cut can be preferred or used as a roast style meat for consumers. Wet-aging enhanced the taurine contents, which is the most functional compound in BF muscle at all aging periods. In addition, the goat meat wet-aged for five days showed good meat quality traits compared to that at 0, 10, and 15 days of aging. Therefore, five days is the optimal wet-aging period under vacuum packaging without any detrimental effects on meat quality and safety.

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