EFFECTS OF SOYBEAN SAUCE AND POST-SLAUGHTER PROCESSING ON QUALITY CHARACTERISTICS OF FROZEN HANWOO (KOREAN NATIVE CATTLE) PATTIES

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***Abstract*— the effects of NaCl (sodium chloride) or soybean sauce and post-slaughter processing were studied on hanwoo (Korean native cattle) patty. The addition of soybean sauce decreased pH values in both of hot-boned and chilled ($P<0.05$) treatments, hot-boned hanwoo patties with containing soybean sauce had lower cooking loss and reduction in a diameter than those made from chilled hanwoo, and showed a similar effect compare to NaCl treatments on physicochemical properties. Especially, hot-boned treatment with containing showed superior sensory properties ($P<0.05$), and had the highest overall acceptability score. Therefore, the utilization of soybean sauce on hot-boned hanwoo provides the improvement of quality characteristics in the production of beef patty.**

***Index Terms*—hot-boning, hanwoo, soybean sauce, beef patty.**

I. INTRODUCTION

Hot-boned muscles (HM) which were immediately removed from the post-slaughter carcass were utilized with having economical advantages and superior processing qualities in many countries. Main benefits of HM may be summarized as follows: 1) Economical advantages include reduction of refrigerator facilities and/or frugality of labor and transport costs (Pisula & Tyburcy, 1996), and 2) processing properties of HM contain the increasing solubility of salt-soluble proteins, emulsifying capacity (Jones, Ray, Thomas, & Tsao, 1986), and water-holding capacity (Honikel & Hamm, 1978) due to higher pH value and ATP (adenosine tri-phosphate) concentration. Many workers have attempted to maintain on processing properties of HM, and they introduced, especially related the tenderness and water-holding capacity, several improvement techniques such as the addition of sodium chloride, phosphate, and/or glucose (Boles & Swan, 1997), calcium infusion (Rees, Trout, & Warner, 2002), electrical stimulation (Jeremiah, Martin, & Murray, 1985), and curing condition (Choi, Kim, Jeong, Lee, Choi, & Kim, 2009). If salt in soybean sauce has a similar effect to compare with the sodium chloride, the production of superior meat products by using soybean sauce and hot-boned meat will be possible. Therefore, we investigate physicochemical properties and quality characteristics of hot-boned frozen hanwoo patties with containing soybean sauce and sodium chloride of an identical concentration.

II. MATERIALS AND METHODS

Materials

Twelve hanwoo cows (24 mon of age; live weights: 774.2 kg; slaughter weights: 470.0 kg) were slaughtered at a local municipal slaughterhouse. After splitting and bleeding, the carcasses were transferred to the cutting room. *Semimembranosus* muscles (SM) were initially ground through an 8 mm plate (PM-100, Mainca, Barcelona, Spain)

within 1 h post-mortem, and then randomly assigned to either a two phase sample of hot-boned and chilled meats. Half of the SM was used immediately as material for hot-boned treatments and the other half meat was used after being stored in polyethylene bags at 4℃ for 48 h as material for chilled treatments. Commercial soybean sauce (Fermented soybean sauce, Sempio Foods Co., Seoul, South Korea) was purchased from the local market. Soybean sauce solution and sodium chlorides solution, which were diluted with ice water, were made at 2% salt concentration and these solutions were added to hot-boned and chilled ground hanwoo. All samples were composed by 80% raw meat, 20% water, and 2% salt concentration.

All samples were mixed by hand for 5 min, before the patties were formed, the batches were held at 4℃ for 1 h. The each sample were processed into 100±1 g patties with 100 mm in diameter and 15 mm in thickness using patty presses (Small round press, Spikomat Ltd., Nottinghamshire, UK), and the samples were packaged with Nylon/PE film, and stored at -20℃ for 3 mon.

Thawing and cooking methods

The used thawing method were refrigerator thawing, and refrigerator thawing were thawing in the 4℃ refrigerator until the core temperature of patties were reached at 4±1℃. The used cooking method was an electric grill cooking, and all patties were cooked on a electric grill (CG20, Hobart, OH, USA) at a grill surface temperature of 150℃. The patties were cooked for 3 min on one side and for 3 min on the opposite side, and thereafter flipped over every 2 min until the targeted core temperature reached at 71℃. All temperature changes were monitored with a digital thermometer (Tes-1305, Tes Electrical Corp., Taipei, Taiwan) equipped with a data logger (RS-232, Tes Electrical Corp., Taipei, Taiwan) by inserting an iron constantan thermocouple. The cooked patties were cooled down to 4℃, and then analyzed rapidly.

Experimental methods

The pH sample was determined with a pH meter (Model 340, Mettler-Toledo GmbH, Schwerzenbach, Switzerland). The instrumental color analysis of hanwoo patties was conducted, color measurements were taken with colorimeter (Chroma meter CR-210, Minolta, Japan; illuminate C, calibrated with white standard plate CIE L^* = 97.83, CIE a^* = -0.43, CIE b^* = +1.98). All patties were weighted before cooking, and were cooked until the core temperature reached at 71℃. After cooling at room temperature for 1 h, cooked hanwoo patties were weighed and a percentage cooking loss was calculated from the weights. To measure the diameter of the same locations before and after a cooking, two points per patty were marked. After each patty was cooked, it was cooled down at room temperature. The diameter of the raw and cooked patties was recorded using Vernier calipers (530-122, Mitutoyo, Kawasaki, Japan). The texture profile analysis was performed in duplicate on each patty, the textural properties of each patty were measured by a spherical probe (5 diameter), set attached to a Texture Analyzer (TA-XSK1*i*, Stable Micro System Ltd., Surrey, U.K.). The hanwoo patties were evaluated for color, flavor, juiciness, tenderness, and overall acceptability. The cooked samples as previously described were cooled to room temperature at 25±1℃ and cut and served to the panelists in random order. An analysis of variance were performed on all the variables measured using the General Linear Model (GLM) procedure of the SAS statistical package (SAS Institute, Inc., 1999). Duncan's multiple range test (P<0.05) was used to determine differences between treatment means.

III. RESULTS AND DISCUSSION

Table 1 show the pH and instrumental color of frozen and cooked hanwoo patties with containing NaCl and soybean sauce. The pH values were significantly lower in soybean sauce treatments compared to NaCl treatments at both of hot-boned and chilled hanwoo patties (P<0.05). CIE L^* values (lightness) were not affected significantly by addition of

soybean sauce and NaCl, after cooking, chilled patty with containing NaCl has the highest lightness (P<0.05). In CIE a^* values (redness), NaCl treatment had higher values than soybean sauce treatments in both of hot-boned and chilled patties (P<0.05). The patties made from hot-boned hanwoo had lower percentages (P<0.05) of cooking loss and reduction in a diameter than that made from chilled hanwoo (Fig. 1.), in hot-boned treatments, the patty with containing NaCl had the lowest cooking loss and reduction in a diameter (P<0.05). The hanwoo patties with the highest (P<0.05) hardness were associated with the chilled treatments (Table 2), hot-boned hanwoo produced patties with lower hardness than those from chilled, this phenomenon was related to hold moisture content of samples, after cooking. All treatments had no significantly the difference in springiness, cohesiveness, and chewiness (P>0.05). The sensory property comparisons of the frozen hanwoo patties containing NaCl and soybean sauce are shown in Table 3. The addition of soybean sauce increased color and flavor scores, and all NaCl treatments received lower scores than the soybean sauce treatments (P<0.05). For tenderness and juiciness scores of hot-boned patties, there is no significantly the difference in between NaCl treatment and soybean sauce treatments (P>0.05). The hot-boned patty with containing soybean sauce, which had high scores for color, flavor, tenderness, and juiciness, was evaluated as excellent in terms of overall acceptability.

Table 1. Effects of soybean sauce on pH and instrumental color on hot-boned and chilled frozen hanwoo patties

Traits		Hot-boned treatment		Chilled treatment	
		NaCl	Soybean sauce	NaCl	Soybean sauce
Before cooking	pH	6.02±0.02^{A}	5.96±0.02^{B}	5.68±0.03^{C}	5.62±0.02^{D}
	CIE L*	42.21±0.93	40.26±1.18	41.86±1.33	39.76±2.84
	CIE a*	7.86±0.66^{A}	5.57±0.43^{B}	6.96±0.40^{A}	5.54±0.85^{B}
	CIE b*	4.23±0.29^{B}	4.07±0.42^{B}	5.29±0.55^{A}	4.31±0.73^{B}
After cooking	pH	6.32±0.02^{A}	6.19±0.02^{B}	5.94±0.03^{C}	5.89±0.03^{D}
	CIE L*	46.63±0.34^{B}	45.45±0.27^{C}	47.88±0.51^{A}	44.27±0.42^{D}
	CIE a*	5.15±0.19^{A}	4.31±0.22^{C}	4.72±0.11^{B}	4.05±0.08^{D}
	CIE b*	4.91±0.42^{A}	4.82±0.37^{A}	4.93±0.14^{A}	4.12±0.30^{B}

All values are mean ± standard deviation of three replicates.
$^{A-D}$ Means within a row with different letters are significantly different (P<0.05).

Fig. 1. Changes of cooking loss and reduction in diameter added NaCl and soybean sauce on hot-boned and chilled frozen hawoo patties.

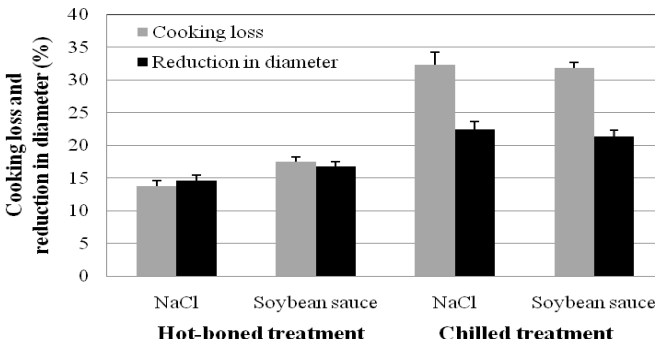

Table 2. Comparisons of texture properties of the hot-boned and chilled frozen hanwoo patties with containing NaCl or soybean sauce

Traits	Hot-boned treatment		Chilled treatment	
	NaCl	Soybean sauce	NaCl	Soybean sauce
Hardness (kg)	1.11±0.08^{B}	1.16±0.08^{B}	1.39±0.06^{A}	1.30±0.11^{A}
Springiness	0.77±0.03	0.79±0.04	0.79±0.04	0.77±0.05
Cohesiveness	0.54±0.03	0.55±0.03	0.53±0.02	0.56±0.03
Gumminess (kg)	0.62±0.10^{C}	0.63±0.05^{BC}	0.75±0.10^{A}	0.72±0.08^{AB}
Chewiness (kg)	0.48±0.04	0.48±0.06	0.53±0.10	0.53±0.08

All values are mean ± standard deviation of three replicates.
$^{A-C}$ Means within a row with different letters are significantly different (P<0.05).

Table 3. Comparisons of sensory scores[1)] of the hot-boned and chilled frozen hanwoo patties with containing NaCl or soybean sauce

Trait	Hot-boned treatment		Chilled treatment	
	NaCl	Soybean sauce	NaCl	Soybean sauce
Color	7.40±0.17^{B}	8.40±0.52^{A}	7.80±0.63^{AB}	8.10±0.57^{AB}
Flavor	7.00±0.47^{C}	8.30±0.42^{A}	7.60±0.26^{B}	8.10±0.57^{AB}
Tenderness	8.20±0.59^{A}	8.10±0.18^{A}	7.90±0.34^{BC}	7.60±0.24^{C}
Juiciness	8.30±0.67^{A}	8.20±0.63^{A}	7.90±0.74^{AB}	7.72±0.08^{B}
Overall acceptability	7.70±0.33^{B}	8.50±0.21^{A}	7.85±0.34^{B}	7.80±0.23^{B}

All values are mean ± standard deviation of three replicates.
$^{A-C}$ Means within a row with different letters are significantly different (P<0.05).
[1)] sensory score : color, flavor, and overall acceptability (1 = extremely undesirable, 10 = extremely desirable), tenderness (1 = extremely tough, 10 = extremely tender), and juiciness (1 = extremely dry, 10 = extremely juicy)

CONCLUSION

Utilization of hot-boned hanwoo provides superior quality characteristics than chilled hanwoo, for cooking loss, reduction in a diameter, and sensory properties. Especially, addition of soybean sauce in hot-boned patty show a similar effect compared to NaCl for physicochemical properties of hanwoo patties. In addition, the reason to obtain the high sensory scores of hot-boned treatment with containing soybean sauce results from peptide groups and nucleotide groups in soybean sauce, probably. Therefore, addition of soybean sauce on hot-boned hanwoo could be utilizedd in a production of commercial beef patty due to improvement of its physicochemical and sensory properties.

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