EFFECTS OF SOYBEAN SAUCE ON PHYSICOCHEMICAL PROPERTIES OF HOT-BONED HANWOO BEEF (KOREAN NATIVE CATTLE)

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***Abstract*— the purpose of this study was carried out to examine the effect of adding Korean fermented soybean sauce (kanjang) on hot-boned Korean native cattle (Hanwoo). Although the addition of the soybean sauce reduced the pH of hot-boned Korean native cattle, it improved the water-holding capacity (WHC), cooking loss, and textural properties due to the salt concentration of the soybean sauce. Especially the addition of the soybean sauce inhibited lipid oxidation in hot-boned Hanwoo and both the pre-rigor Hanwoo had the lowest TBA values at the highest soybean sauce content ($P<0.05$). The hot-boned treatment with containing 2.0% soybean sauce solution had better properties than the control (sodium chloride 2.0%), in terms of WHC, cooking loss, TBA, and textural properties, with the addition of the soybean sauce.**

***Index Terms*—hot-boning, hanwoo, pre-rigor, kanjang, soybean sauce**

I. INTRODUCTION

In Korea, soybean sauce has been utilized as a marinade on a variety of Korean traditional meat products, such as bulgogi (Korean style barbecued beef), galbi jjim (braised short ribs), and tteokgalbi (Korean style beef meatball), which are traditionally produced by using Korean native cattle (hanwoo). These meat products have recently come to the attention of foreigners due to the special flavor and taste with the addition of the soybean sauce. Soybean sauce (kanjang) is a fermented food derived from soybean. This soybean sauce contains salt (approximately 15-20% of salt concentration), water (approximately 50-70%), peptides, isoflavon, free sugar, and organic acids derived from the soybeans during fermentation period (Kim, Jo, Yook, Park, & Byun, 2002; Shim et al., 2008). Recently, many studies have examined the effects of the soybean sauce on the physicochemical properties of pork meat and quality characteristics of pork products (Choi et al., 2006; Jin et al., 2004). Also, the color properties of the soybean sauce are influenced by melanoidins, which are formed when carbonyl compounds and amino compounds combine (maillard reaction). The melanoidins in soybean sauce are important to the antioxidative properties of the sauce (Choi, Lee, Moon, & Park, 1990). Moon and Cheigh (1986) demonstrated that soybean sauce in cooked beef plays an important role as an antioxidant.

Utilization of pre-rigor muscles, which are treated by hot-boned processing or accelerated processing, has been known to have many advantages, including a reduction in cooler space, decreased energy cost and an increase in final yield as well as an improvement in meat quality (Hamm, 1981). Bernthal, Booren, and Gray (1989) reported that pre-rigor meat containing salt has better physicochemical properties than post-rigor meat. In addition, Boles and Swan (1997) showed that the type of brine ingredients affects the meat properties of both pre- and post-rigor beef. As mentioned above, soybean sauce has a high salt content and several beneficial substances; however, no study has examined the effects of soybean sauce on hot-boned meats.

Therefore, the objective of this study was to investigate the effects of various soybean sauce concentrations on the quality characteristics of hot-boned ground Hanwoo.

II. MATERIALS AND METHODS

Sample preparations

Twelve hanwoo cows (24 month 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 removed immediately, and trimmed of visible fat and connective tissue. SMs were placed in polyethylene bags and transported to the Meat Science laboratory at Konkuk University, South Korea. SMs were initially ground through an 8 mm plate (PM-100, Mainca, Barcelona, Spain) within 1 h post-mortem, and then randomly assigned to hot-boned meats. Commercial soybean sauce (Fermented soybean sauce, Sempio Foods Co., Seoul, South Korea) was purchased from the local market. Soybean sauce solutions, which were diluted with ice water, were made at three different salt concentrations (0.5, 1, and 2% w/w). The formulation of samples were used as follows: Control (hot-boned Hanwoo meat 80%, ice water 20%, and sodium chloride 2%), T1 (hot-boned Hanwoo meat 80% and soybean sauce solution (0.5% salt concentration) 20%, T2 (hot-boned Hanwoo meat 80% and soybean sauce solution (1.0% salt concentration) 20%, and T3 (hot-boned Hanwoo meat 80% and soybean sauce solution (2.0% salt concentration). Samples were mixed by hand for 5 min, and then analyzed immediately.

Methods

The pH values of samples were measured in a homogenate prepared with 5 g of sample and distilled water (20 ml) using a pH meter (Model 340, Mettler-Toledo GmbH, Schwerzenbach, Switzerland). WHC (water-holding capacity) was determined in triplicate by filter paper pressed method (Grau, & Hamm, 1953). Cooking loss was determined by calculating the weight differences before and after cooking (core temperature 75 ˚C). Lipid oxidation was assessed in triplicate by the 2-thiobarbituric acid (TBA) method of Tarladgis, Watts, Younathan, and Dugan (1960) with minor modifications. Thiobarbituric acid-reactive substances (TBARS) were calculated from a standard curve (8-50 nmol) of malondialdehyde (MDA), freshly prepared by acidification of TEP (1,1,3,3-tetraethoxy propane). The TBA levels of samples were measured at post-mortem 1, 12, 24, 48, and 168 hr, and were calculated as mg MDA/kg meat. Texture profile analysis was performed at room temperature with a texture analyzer (TA-XT2*i*, Stable Micro Systems, Surrey, England). Cooked meat samples were taken from the central portion of each meat. Prior to analysis, samples were allowed to equilibrate to room temperature (20 ˚C, 3 h). The conditions of texture analysis were as follows: pre-test speed 2.0 mm/s, post-test speed 5.0 mm/s, maximum load 2 kg, head speed 2.0 mm/s, distance 8.0 mm, force 5 g. The calculation of TPA values was obtained by graphing a curve using force and time plots. An analysis of variance was performed on all the variables measured using the general linear model (GLM) procedure of the SAS statistical package (1999). Duncan's multiple range test ($P<0.05$) was used to determine the differences between treatment means.

III. RESULTS AND DISCUSSION

Table 1 show the pH, WHC (water-holding capacity), and cooking loss of hot-boned ground Korean native cattle (hanwoo) containing various soybean sauce concentration. The pH value of treatments decreased with more increasing of soybean sauce concentration ($P<0.05$). Jeon, Sohn, Chae, Park, and Jeon (2002) reported that the low pH value of the soybean sauce is caused by the proliferation of lactic acid bacteria during the fermentation period. The highest WHC values were obtained for T3, which had a much lower pH value than the other treatments ($P<0.05$). T1 and T2 had lower WHC and higher cooking loss due to lower salt concentration than control. The TBA values of hot-boned and chilled hanwoo containing various soybean sauce concentrations are shown in Fig. 1. The statistical analyses indicated that the TBA values of the hanwoo meat were significantly affected by the addition of soybean sauce ($P<0.05$). Moon and Cheigh (1986) reported that the addition of soybean sauce had an obvious antioxidative effect on the lipid oxidation of beef meat, and Jeon, Sohn, Chae, Park, and Jeon (2002) indicated that the antioxidative properties of soybean sauce was related to melanoidin, which is formed by the maillard reaction. Table 3 shows the comparison of the texture properties of the hot-boned hanwoo with containing various soybean sauce concentrations. The HT3 treatment had the highest values in all textural properties ($P<0.05$), and all hot-boned treatments had a higher hardness, gumminess, and chewiness than the control ($P<0.05$). All textural properties were improved with the addition of the soybean sauce, Choi, Jeong, Kim, An, and Kim (2008) reported that when the salt concentration in ground type meat products was increase, the hardness increased and the structure changed substantially due to the increased ionic strength, which is similar to the results obtained in this study.

IV. CONCLUSION

The results have shown that soybean sauce is worthy of notice as a brine agent. Generally, salted pre-rigor muscle has higher pH, WHC, Cooking loss, and textural properties than salted post-rigor muscle due to effect of salt on pre-rigor muscle. Under the identical salt concentration, soybean sauce improved physicochemical properties of hot-boned ground hanwoo in comparison with sodium chloride. This phenomenon was speculated about the effect of various materials in soybean sauce, such as organic acid, peptides, and sugar component. Furthermore, we will carry out that what a component in soybean sauce influence physicochemical changes of post-mortem muscle, and define the difference between addition of soybean sauce and addition of sodium chloride.

Table 1. Effects of soybean sauce on pH, WHC[1)], and cooking loss on hot-boned Hanwoo

Traits	Control	Treatments		
		T1	T2	T3
pH	6.16±0.02^{C}	6.33±0.03^{A}	6.22±0.02^{B}	6.05±0.02^{D}
WHC (%)	89.15±3.48^{A}	64.99±4.67^{C}	75.14±4.72^{B}	91.51±5.17^{A}
Cooking loss (%)	23.12±0.56^{A}	29.97±0.72^{C}	28.04±0.14^{B}	22.25±0.84^{A}

All values are mean ± standard deviation of three replicates.
$^{A-D}$ Means within a row with different letters are significantly different (P<0.05).
$^{1)}$ WHC : water holding capacity.

Fig. 1. Comparisons of MFI of hot-boned Hanwoo with containing various soybean sauce levels.

$^{1)}$ MFI : myofibrillar fragmentation index.

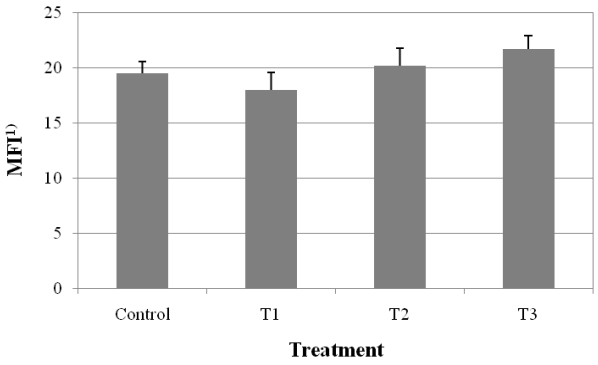

Table 2. Effects of soybean sauce on TBA values on hot-boned Hanwoo during storage periods

Storage periods	Control	Treatments		
		T1	T2	T3
1 h	0.08±0.02^{e}	0.09±0.03^{c}	0.08±0.02^{c}	0.08±0.02^{b}
12 h	0.14±0.02^{Ad}	0.08±0.02^{Bc}	0.09±0.02^{Bc}	0.09±0.03^{Bb}
24 h	0.18±0.01^{Ac}	0.13±0.02^{Ab}	0.12±0.01^{ABb}	0.09±0.02^{Bb}
48 h	0.28±0.03^{Ab}	0.15±0.03^{Bb}	0.13±0.02^{Bb}	0.09±0.05^{Bb}
168 h	0.42±0.03^{Aa}	0.21±0.02^{Ba}	0.18±0.03^{BCa}	0.17±0.03^{Ca}

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

Table 3. Texture profile analysis of hot-boned Hanwoo with containing various soybean sauce levels

Traits	Control	Treatments		
		T1	T2	T3
Hardness (N)	9.55±0.58^{A}	7.87±0.70^{B}	9.18±0.79^{A}	9.98±0.56^{A}
Springiness	0.82±0.05^{A}	0.77±0.07^{B}	0.74±0.05^{B}	0.82±0.02^{A}
Cohesiveness	0.63±0.05^{A}	0.47±0.05^{C}	0.58±0.02^{B}	0.64±0.04^{A}
Gumminess (N)	6.18±0.74^{AB}	3.69±0.27^{C}	5.31±0.41^{B}	6.38±0.28^{A}
Chewiness (N)	5.10±0.19^{A}	2.88±0.26^{C}	3.97±0.25^{B}	5.25±0.21^{A}

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

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