THE EFFECTS OF MARINATING WITH COMMERCIAL VINEGARS ON THE QUALITY CHARACTERISTICS OF *BICEPS FEMORIS* MUSCLE ON HANWOO

Pil-Nam Seong[1], Jin-Hyoung Kim[1], Soo-Hyun Cho[1], Geun-Ho Kang[1], Beon-Young Park[1], Kyoung-Mi Park[1], Dong-Hoon Kim[1] and Dawoon Jeong[2]

[1]National Institute of Animal Science, RDA, Suwon, Republic of Korea; [2]Department of Animal Science and Institute of Rare Earth for Biological Application, Chonbuk National University, # 664-14 Duckjin-Dong, Jeonju 561-756, Republic of Korea.

Abstract – This study was implemented to verify the effects of marinating beef with thirteen different commercial vinegars on quality traits of *biceps femoris* (BF) muscle of Hanwoo cow. The pH and cooking loss of marinated meat tended to decrease on all the vinegars and the swollen rate of the marinated meat was found to increase only on pomegranate vinegar. The shear force decreased on all the thirteen commercial vinegars except for persimmon vinegar. Most of the commercial vinegars affected the water holding capacity of the marinated meat, excluding those marinated on omija-persimmon, pomegranate and grape vinegars. The yield was greatest with the alone-apple vinegar, and lowest with strawberry and persimmon vinegars ($p<0.05$).

Keywords – Meat quality, Simple marination, Water holding capacity,

I. INTRODUCTION

As the consumption pattern for beef in Korea has changed from "bulgogi" to steak, there is a serious imbalance in the consumption such as sirloin and tenderloin has increased sharply, low quality parts such as rump, bottom round, shoulder, shin fore shank and boston butt are low in price, and sales for these have decreased due to the slowdown in consumption. Therefore, a plan to increase the consumption for these parts is badly needed. Since low quality parts are considered as unsavory and tough meats, developing food processing techniques to improve meat quality is a primary need for promoting consumption.

Marinating which is a traditional technique used to improve tenderness as well as to give meat a different flavor [1-4]. In many countries, marinades for marinating meat and even marinated meats are widely available in the market, and interests in these products are increasing. However, especially in Korea, studies on meat-tenderizing techniques with vinegars which can provide positive effects on health such as anticancer [5] and antioxidant [6-8] effects, and in improving the immune system as well as tenderizing meats are inadequate.

Therefore, this study was conducted to compare the effects of different kinds of vinegar available in the market on meat quality and present the data obtained from this study as a basis for companies in developing acid marinade products as marinating material.

II. MATERIALS AND METHODS

Experimental design and treatments

Five Hanwoo (aged 7-14 years) were slaughtered and chilled for 24 hours. *M.biceps femoris* samples were taken from right side of carcasses. Each muscle was divided into thirteen portions with same sizes (7 x 3 x 3 cm; W x L x H), and injected with vinegar, which was diluted 4 times in distilled water. The injected vinegar volume was equivalent to 10% of the sample weight. For the marinating process, 13 different vinegars were used, which were all available in the market of Korea as follows: A = Aloe-apple vinegar; B=Brown rice vinegar; C = Persimmon vinegar; D = Aloe vinegar; E = Omija-Persimmon vinegar; F=Pomegranate vinegar; G = Young pine needles vinegar; H = Apple vinegar; I = Strawberry vinegar; J = Wild grape vinegar; K = Phellinus

Linteus brown rice vinegar; L = Mulberry vinegar, and; M = Grape vinegar. The samples were all marinated for 15 hrs at 4 ^{o}C, after which they were used for different experiments.

Meat quality trait

The pH was measured with a probe type pH meter (pK-21, NWK-Binar GmbH Co., Germany). Determination of swelling rate was done following the procedure of Sheard and Tali [9] and the water holding capacity was done following the procedure of Park *et al.* [4]. Samples for Warner Bratzler shear force values were cooked in water at 80^{o}C and measured in an Instron Universal Testing Machine (Model 4465, Instron Corporation, UK) on core samples with 0.5 inch diameter using a crosshead speed of 400 mm/min and a 40 kg_f load cell. The weights of the meat before and after cooking were recorded.

Statistical analysis

Significant differences between the treatments were tested by variance analysis (ANOVA) with $p<0.05$ by the Duncan's multiple range test using SAS program [10].

III. RESULTS AND DISCUSSION

Figure 1 indicates the effects of marinating with commercial vinegars on pH level of meats. The pH of raw beef was in the range of 5.51 to 5.60, and decreases to 5.11-5.37 after vinegar marinating process. The swelling rate of all samples (Table 1) was from -0.07% to 3.22%, which indicates that the weight of *biceps femoris* increases for all kinds of vinegar marinades, except for pomegranate vinegar (F). Meaningful differences in this and the swelling rate for muscle are not found ($p>0.05$). The cooking loss was between 38.98 and 44.32 % for all kinds of vinegar, with aloe-apple vinegar (A) showing the lowest degree of cooking loss ($p<0.05$). Aloe apple vinegar (A) further showed the highest degree of yield, while strawberry vinegar (I) and persimmon vinegar (C) indicated the lowest yield. For water-holding capacity (Table 2), all vinegars except for Omija-persimmon vinegar (E), pomegranate vinegar (F) and Grape vinegar (M), wherein there was a reduced water-holding capacity.

Comparison of the WBSF suggests that Phellinus linteus brown rice vinegar (K, 15.84% decrease) tenderizes the meat the most, however, statistical and meaningful differences between each vinegar are not found (Table 3).

The decreased pH of meat was primarily due to acid marinating. Similar results were also reported by other studies. Wenham and Locker [11] reported a decrease in meat pH when marinating time was increased and more concentration of acid in vinegars was used [12]. It was also indicated that aloe-apple vinegars was suitable to improve yield [1].

There is still an argument about the mechanism and effect of marinating in improving tenderness. Gault [1] reported that the different improvement in tenderness depend on marinating treatment [6]. In the present study, the marinating treatment did not show much variation, but we could see a potential trend in improving tenderness.

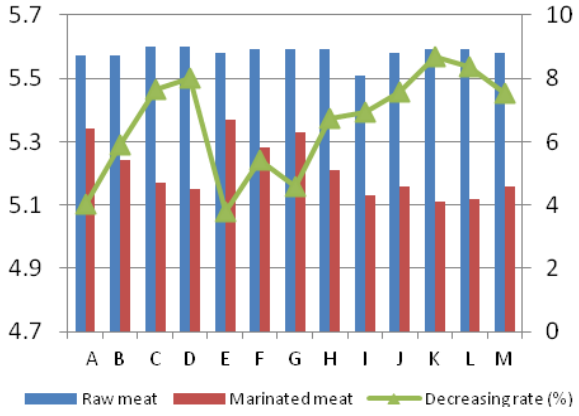

Figure 1. The effects of marinating with commercial vinegars on pH of Hanwoo *biceps femoris* muscle (A: Aloe-apple vinegar, B: Brown rice vinegar, C: Persimmon vinegar, D: Aloe vinegar, E: Omija-Persimmon vinegar, F: Pomegranate vinegar, G: Young pine needles vinegar, H: Apple vinegar, I: Strawberry vinegar, J: Wild grape vinegar, K: Sang-hwang brown rice vinegar, L: Mulberry vinegar, M: Grape vinegar).

Table 1. The effects of marinating with commercial vinegars on swelling rate, cooking loss and yield of Hanwoo *biceps femoris* muscle (Unit: %)

Items[1)]	Swelling rate	Cooking loss	Yield
A	2.43±1.79	38.98±2.40[b]	61.35±2.35[a]
B	3.22±1.87	42.41±1.20[a]	58.07±0.97[ab]
C	3.10±1.93	44.12±1.37[a]	56.31±1.19[b]
D	1.75±0.55	41.17±0.58[ab]	59.52±0.71[ab]
E	0.79±0.83	42.06±0.62[ab]	58.01±0.52[ab]
F	-0.07±0.52	40.99±0.78[ab]	59.09±0.84[ab]
G	2.08±0.57	43.07±0.64[a]	57.84±1.10[ab]
H	1.65±0.42	43.36±0.16[a]	57.91±0.17[ab]
I	1.60±0.88	44.32±0.59[a]	56.23±1.00[b]
J	2.33±0.75	43.66±1.12[a]	57.56±1.29[ab]
K	2.40±0.66	43.22±1.02[a]	57.79±1.58[ab]
L	2.30±0.89	42.69±0.79[a]	58.42±1.28[ab]
M	2.79±0.75	42.56±0.91[a]	58.88±1.00[ab]

[a, b] Means with different superscripts in the same column differ significantly ($p<0.05$).

[1)] A: Aloe-apple vinegar, B: Brown rice vinegar, C: Persimmon vinegar, D: Aloe vinegar, E: Omija-Persimmon vinegar, F: Pomegranate vinegar, G: Young pine needles vinegar, H: Apple vinegar, I: Strawberry vinegar, J: Wild grape vinegar, K: Sang-hwang brown rice vinegar, L: Mulberry vinegar, M: Grape vinegar.

All values are means±standard error.

Table 2. The effects of marinating with commercial vinegars on water holding capacity (%) of Hanwoo *biceps femoris* muscle

Items[1)]	Raw meat	Marinated meat	Rate of Increase (%)
A	52.55±2.78[*]	50.57±3.97[*]	-1.99±2.19[**abc]
B	52.55±2.78	48.31±2.63	-4.24±0.78[abc]
C	52.61±2.66	50.47±2.28	-2.14±1.44[abc]
D	53.18±3.10	50.31±4.03	-2.87±0.69[abc]
E	49.98±4.86	50.43±2.38	0.45±1.70[a]
F	49.57±4.26	49.89±2.52	0.32±0.98[ab]
G	50.51±4.40	48.02±2.49	-2.49±1.23[abc]
H	50.51±4.40	50.47±2.13	-0.04±1.90[ab]
I	52.02±0.52	46.74±1.65	-5.27±0.94[c]
J	52.18±0.25	47.83±1.52	-4.35±0.73[bc]
K	52.06±0.29	51.32±1.36	-0.75±0.84[abc]
L	52.06±0.29	51.20±2.67	-0.87±1.68[abc]
M	52.06±0.29	52.18±1.69	0.12±1.09[ab]

[a, b] Means with different superscripts in the same column differ significantly ($p<0.05$).

[1)] A: Aloe-apple vinegar, B: Brown rice vinegar, C: Persimmon vinegar, D: Aloe vinegar, E: Omija-Persimmon vinegar, F: Pomegranate vinegar, G: Young pine needles vinegar, H: Apple vinegar, I: Strawberry vinegar, J: Wild grape vinegar, K: Sang-hwang brown rice vinegar, L: Mulberry vinegar, M: Grape vinegar.

All values are means±standard error.

Table 3. The effects of marinating with commercial vinegars on shear force (kg/0.5 inch^2) of Hanwoo *biceps femoris* muscle

Items[1)]	Raw meat	Marinated meat	Decreasing rate (%)
A	8.76±1.81[*]	8.21±1.75[*]	5.81±4.87[**]
B	8.64±1.61	8.52±1.36	0.22±6.20
C	8.76±1.72	8.78±1.79	-2.10±9.47
D	8.71±1.74	8.02±1.24	6.25±6.58
E	9.06±1.45	8.16±1.26	8.69±7.17
F	9.07±1.44	8.17±1.72	8.91±8.04
G	8.67±1.29	8.37±0.49	1.24±8.81
H	8.67±1.29	7.91±2.20	5.32±16.06
I	9.51±1.63	8.46±1.89	10.05±8.43
J	10.32±2.20	8.38±0.68	15.53±8.86
K	9.95±2.05	7.97±1.05	15.84±11.98
L	9.95±2.05	8.46±1.23	11.65±10.07
M	10.22±1.75	8.87±1.74	12.80±6.31

[*] Values are means±standard deviation.

[**] Values are means±standard error.

[1)] A: Aloe-apple vinegar, B: Brown rice vinegar, C: Persimmon vinegar, D: Aloe vinegar, E: Omija-Persimmon vinegar, F: Pomegranate vinegar, G: Young pine needles vinegar, H: Apple vinegar, I: Strawberry vinegar, J: Wild grape vinegar, K: Sang-hwang brown rice vinegar, L: Mulberry vinegar, M: Grape vinegar.

IV. CONCLUSION

In the present study, there were some deviations in the results which could be due to sample collection and processing, but still the present results showed promising improvements in meat quality such as yield, tenderness, etc. With an improvement of experimental design and process for future work, the results could be suggested to industrial utilization wherein low-quality meat could be improved by simple marination.

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