EFFECT OF ELECTRICAL STIMULATION ON FREE AMINO ACID OF BEEF BICEPS FEMORIS MUSCLE

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Abstract – The objective of this current study was to identify effects of ES and chiller ageing on concentrations of flavor precursor amino acids of beef. The BF muscles of right side carcasses from Hanwoo steers (n=8) and cows (n=8) were electrically stimulated within 30 min postmortem for 60 s using 60 volts and aged 2 and 14 days. The left side of carcasses used as a control. The degradation of Troponin-T was little faster on ES treatment group than aging time. Amount of total amino acids significantly increased during aging. Content of amino acids of ES group were not significantly but apparently higher than control in both aging days. It seemed that ES may enhance desirable meat flavor by effectively increasing level of free amino acids than aging treatment.

Key Words – beef, electrical stimulation, amino acids, protein degradation

I. INTRODUCTION

The electrical stimulation (ES) could be one of useful technique of meat tenderizing, ES causes muscle contractions and increases the rate of glycogen usage that will increase the rate of pH decline in muscles [1; 2]. This accelerated pH decline can increase calpain proteolytic activity which improves meat tenderness [3; 4]. ES was also found to enhance the rate of Tn-T degradation during aging of muscle [5]. When proteins are degraded by enzymes during meat ageing they give rise to protein fragments which are they further degrade, releasing small peptides and free amino acids that may contain information regarding the taste and odor of the meat and meat products [6]. Thus this study was conducted to investigate effects of ES on level of free amino acids of Hanwoo beef, also to compare them with protein degradation and meat aging effect.

II. MATERIALS AND METHODS

Sample preparation; A total of nine Korean native Hanwoo cows and nine steers were slaughtered by conventional procedure. Carcasses were immediately transferred to chilled room and right side of each carcass was electrically stimulated. The left side of the carcass was used as a control. Briefly, ES was applied by using laboratory-made two-multi point electrode probe, (probe was produced for easily earthling until inside of back fat). The condition was 60 volt, direct current for 60 sec and the whole process completion time was within 30 min of slaughter. The samples were stored at 4^{o}C in chilling room for additional aging 2 and 14 days.

SDS-Page-Western blot were determined by following method of Wheeler (2010)

Free amino acid analyses; Muscle (0.2 g) was sonicated with 100% ethyl alcohol containing 0.4% formic acid and then centrifuged. Chromatography was performed using a LC-MS/MS (Agilent 6430, USA). The quantitative analyses of amino acids in meat extracts were carried out on Intrada Amino Acid (50 x 3 mm). The solvent A was CH3CN: THF: 25mM $HCOONH_4$: HCOOH (9/75/16/0.3 v/v/v/v) and B mobile phase was CAN:100 mM $HCOONH_4$ (20/80 v/v). Column temperature was 40^{0}C and flow rate was 0.6 mL/min.

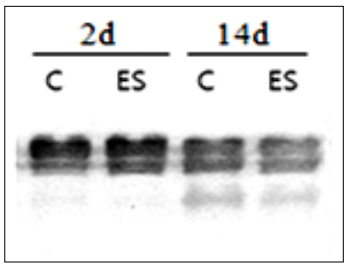
III. RESULTS AND DISCUSSION

In current study Troponin-T degradation was activated by calpains that may induced with ES treatment (Fig 1). The degradation of troponin-T was little faster on ES treatment than aging time. Proteolysis of myofibrillar proteins appears to be major contributor tenderization during post

mortem aging [7] and degree of disruption of these proteins such as Troponin-T involve releasing amino acids [5]. The changes in content of amino acids of m. *Biceps femoris* during ageing 2 to 14 days as affected by ES summarized in Table 1. Total amount of free amino acid in ES group were higher than control samples in both 2 to 14 aged. Total amount of free amino acids significantly increased during aging time (from 589.1 to 809.6 for controls and from 614.1 to 846.1 for ES respectively).

The mean values for each amino acid indicated that Ala was present at the highest concentrations, and that Asp and Cys2 were present at the lowest in both treatments. The Ala has sweet and slight umami taste was one of the major free amino acids in beef and pork [8]. While sulfur-containing amino acids such as cystein and cystine which have low detection threshold are produce meat like, sweet flavor. The reaction between one amino acid (i.e., Cys2) and one sugar will yield hundreds of volatile compounds. Therefore these free amino acids are also great determinants of both palatable meat taste and flavor by generating volatile compounds through Maillard reactions and Strecker degradations. In addition amount of Ile was significantly, other important taste active compounds such as Met Phe Pro and Val slightly increased in ES group. Although Met and Phe are produce the important volatile compounds such as methional, and phenylacetaldehyde which gives cooked potato, honey-like and sweet odor by the Strecker degradations, while Pro produce the roasty and sweet flavor in cooked beef during Maillard reaction [9]. Chen and Zhang [10] reported that free aromatic amino acids such as Phe and Tyr also play an important role in enhancing savory or umami taste at their sub threshold concentrations in the presence of salt and free acidic amino acids.

Figure 1. Effect of electrical stimulation on Tn-T degradation patterns of BF muscles (C, control; ES, Electrical stimulation)



Thus, different concentration of free amino acids were probably involved to the different proteolysis level which affected by ES treatment. Similar results were reported by Mikami et al., [5] who noted that ES may contribute meat flavor by increasing small peptides and free amino acids. These researchers also noted that origins of these flavor precursors are derived from myofibrillar proteins as well as sarcoplasma. More extensive research is needed to measure the role of each flavor precursor, especially peptides and amino acids to produce palatable meat

IV. CONCLUSION

In this research, ES (60V/60 s) had an effect on proteases. The degradation of troponin-T was little faster on electrical stimulation treatment than aging time. The electrical stimulation treatment of a beef increased the content of amino acids, which more affects meat flavor than aging treatment.

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Table 1. Quantity (μg/g) of amino acid of *Biceps femoris* muscles from Hanwoo beef as affected by electrical stimulation

	Ageing 2 days		Ageing 14 days		F value		
Amino acids	Control	ES	Control	ES	Ageing	ES	Ageing*ES
Gly	17.48	17.71	19.82	21.05	6.35*	0.41	0.2
Ala	180.4	185.6	204.8	199.2	4.69*	0	0.39
Ser	81.4	86.08	93.12	103.3	12.5*	0.14	3.41
Pro	13.62	18.98	19.33	20.65	3.34	2.6	0.94
Thr	25.74	25.58	33.61	36.56	21.4***	0.47	0.58
Glu	54.83	49.8	63.97	61.55	4.36*	0.56	0.07
Asp	5.12	4.93	6.94	6.94	7.3*	0.02	0.02
Val	27.1	34.4	53.31	56.88	44.65***	2.23	0.26
Leu	53.74	57.71	94.8	105.1	43.69***	1.12	0.24
Ile	19.3	25.79	41.93	46.59	51.39***	3.39*	0.09
Lys	19.55	12.61	31.97	26.86	20.85***	4.26*	0.1
His	11.56	12.39	15.69	15.9	20.7***	0.38	0.14
Phe	26.13	26.13	42.9	47.47	40.15***	0.58	0.58
Arg	24.46	26.27	35.11	38.73	16.74**	0.93	0.1
Tyr	8.59	6.48	10.85	11.69	23.95***	0.69	3.76
Met	10.47	13.96	31.81	38.01	45.56***	2.08	0.16
Cys2	9.60	9.61	9.61	9.61	0	0	0
Total AA	589.1	614.1	809.6	846.1	12.6*	2.8	4.1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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