BIOLOGICAL ATTRIBUTES OF INTRAMUSCULAR CONNECTIVE TISSUE COMPONENTS OF HANWOO SKELETAL MUSCLE

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Abstract –The present study investigated the effect of muscle type and post-mortem ageing (3day and 21 day) on intramuscular connective tissue (IMCT) properties. *Psoas major* (PM, tenderloin), *Longissimus thoracis* (LT, ribeye), *Longissimus lumborum (LL,* striploin*), Gluteus medius* (GM, top-sirloin butt), *Semimembranosus* (SM, top inside round), *Semitendinosus* (ST, eye of round), *Biceps femoris* (BF, outside flat round), *Triceps brachii (TB, chuck roll), Supraspinatus* (SS, *chuck tender),* and *Diaphragm* (DP, outside skirt) muscles were used from Hanwoo steer (n=15). Total collagen greatly affected (P<0.001) by the muscle type. TB muscle had the significantly (P<0.001) highest quantity of total collagen. In conclusion, variations in intramuscular connective tissue properties could be attributed to tenderness differentiation of beef.

Key words: Collagen, muscle, tenderness.

I. INTRODUCTION

Hanwoo beef is the most favorite among the meats consumed by Korean consumers due to tenderness compared with beef from other breeds or imported beef [1]. The each muscle has its own physiological function in the regulation of body activities, thus the physical-chemical compositions also vary among the muscles to correspond with their function. Collagen is present in 19 different forms, each having a different role in biological systems [2]. The degree to which connective tissues affect tenderness is determined by the type and amount of collagen content. The amount of collagen present in muscle tissue is important in understanding the effect on meat quality parameters. Every single muscle can respond in a different manner in a degree to which their tenderness increase after postmortem ageing periods due to divergences in connective tissue [3]. Therefore, the aim of the present study was to evaluate the effect of muscle types and postmortem ageing on intramuscular connective tissue properties of Hanwoo steer beef.

II. MATERIALS AND METHODS

The ten muscles were collected from fifteen 25 -30 months age of Hanwoo steer. The muscles aged for 3 day and 21 day. The collagen content was determined by Kolar [4] and Hill method with slight modification. Collagen extraction was performed by the methods of Muralidharan et al., [5] and Sato et al., [6] with slight modification. SDS-PAGE was performed according to the method of Laemmli [7] using 6% separating gel and 4% stacking gel. The densitometry for collagen protein specific bands was done on Gel Documentation System (Alpha Innotech, USA) with the help of AlphaEase™ FC Stand Alone V.4.0 software. Data were analyzed using the GLM procedure of SAS Version 9.3.

III. RESULTS AND DISCUSSION

Total and soluble collagen contents of 10 different muscles revealed a wide range variation (Table 1). The PM had the lowest total collagen content, followed by LT, LL, SM, ST and DP. TB had the highest total collagen content. Total collagen content greatly affected (P<0.001) by muscle type at 3 days ageing. There were no significant differences in total collagen content among PM, LT and LL muscle. The total collagen content assumed to be the vital estimation of tenderness among muscles. Total collagen content increases in 21 days chiller ageing period due to the breakdown of perimysial collagen and extracellular matrix by metalloproteinase (MMPs) enzyme which helps in yielding a higher amount of hydroxyproline [8]. In terms of collagen solubility, there are significant muscle and ageing effects on collagen solubility (P<0.01).

The quantification of the particular band for type I and III collagen was significantly affected by muscle type and ageing. Regarding type I collagen at 3 day postmortem ageing ST muscle had the significantly (P<0.001) highest percentage of type I collagen than the other muscle, whereas PM muscle had the lowest. Quantity value of type I collagen, the studied muscles can be organized in the following order BF>DP>TB>ST>SS>GM>SM>LL>LT>PM. In case of 21 day ageing condition the relative quantity value of Type I collagen rises in all muscle, while BF muscles showed the significantly higher values and PM muscle shows the lowest quantity value (p<0.001).

Table 1. Effects of muscle type and postmortem aging on collagen characteristics

Muscles	Total collagen, g/100g		Insoluble collagen, g/100g		Col. solubility, g/100g		Type I collagen		Type III Collagen		Ratio (I:III)	
	3d	21d	3d	21d	3d	21d	3d	21d	3d	21d	3d	21d
PM	0.21^{d}	0.28^{e}	0.09^{e}	0.15^{cd}	0.11^{d}	0.13^{e}	11.57^{iY}	12.68^{iX}	2.15^{jX}	1.93^{jY}	5.39^{aY}	6.57^{aX}
LT	0.29^{d}	0.27^{e}	0.15^{de}	0.11^{d}	0.13^{cd}	0.16^{de}	11.76^{hY}	12.60^{iX}	2.63^{iX}	2.38^{iY}	4.53^{bY}	5.30^{cX}
LL	0.29^{d}	0.28^{e}	0.16^{de}	0.14^{d}	0.14^{cd}	0.14^{e}	12.57^{gY}	13.71^{hX}	2.91^{hX}	2.55^{hY}	4.32^{cY}	5.38^{bX}
GM	0.50^{bc}	0.43^{de}	0.31^{bc}	0.24^{cd}	0.24^{ab}	0.19^{cd}	15.45^{eY}	15.81^{fX}	3.93^{fX}	3.72^{fY}	3.93^{dY}	4.25^{fX}
SM	0.37^{cd}	0.34^{de}	0.19^{cde}	0.15^{cd}	0.18^{bcd}	0.18^{cd}	13.44^{fY}	14.71^{gX}	3.20^{gX}	3.01^{gY}	4.20^{cY}	4.89^{dX}
BF	0.60^{b}	0.64^{b}	0.36^{b}	0.31^{bc}	0.24^{ab}	0.33^{a}	17.25^{aY}	18.69^{aX}	5.11^{aX}	4.67^{aY}	3.38^{gY}	4.00^{gX}
ST	0.61^{b}	0.51^{bc}	0.32^{bc}	0.26^{cd}	0.29^{ab}	0.25^{bc}	16.20^{cY}	16.77^{dX}	4.36^{dX}	3.95^{dY}	3.72^{eY}	4.25^{fX}
SS	0.53^{bc}	0.54^{bc}	0.28^{bcd}	0.31^{bc}	0.26^{abc}	0.23^{bc}	15.65^{dY}	16.36^{eX}	4.47^{cX}	4.06^{cY}	3.51^{fY}	4.03^{gX}
DP	0.65^{b}	0.66^{b}	0.36^{b}	0.39^{ab}	0.29^{ab}	0.26^{ab}	16.60^{bY}	17.39^{bX}	4.60^{bX}	4.34^{bY}	3.61^{cfY}	4.01^{gX}
TB	1.02^{a}	0.85^{a}	0.67^{a}	0.52^{a}	0.36^{a}	0.33^{a}	16.53^{bY}	17.21^{cX}	4.26^{eX}	3.90^{eY}	3.88^{dY}	4.42^{eX}
SEM	0.06	0.06	0.05	0.05	0.04	0.03	0.1	0.05	0.03	0.01	0.04	0.03
						F value						
Muscle	16.2^{***}	10.8^{***}	11.7^{***}	5.9^{***}	4.1^{***}	5.9^{***}	1746^{***}	1750^{***}	721^{***}	547^{***}	188^{***}	914.7^{***}
Aging	1.2		1.8		0.1		1541^{***}		6545^{***}		1657^{***}	

$^{a-i,}$ means within each column with different superscripts in muscle type sections are significantly different , $^{X, Y}$, means within each row with different superscripts in aging days sections are significantly different , *** $P<0.001$, ** $P<0.01$, * $P<0.05$

In terms of type III collagen, amount varied ($P<0.001$) among muscles. The amounts were numerically in the order of BF>DP>SS>ST>TB>GM>SM>LL>LT>PM. The high quality muscles have lesser amount of the type III collagen and higher amount of type I and III collagen existent in muscles were increased toughness of meat. Type III collagen amount declined for every muscle during 21 d aging (Table 1).

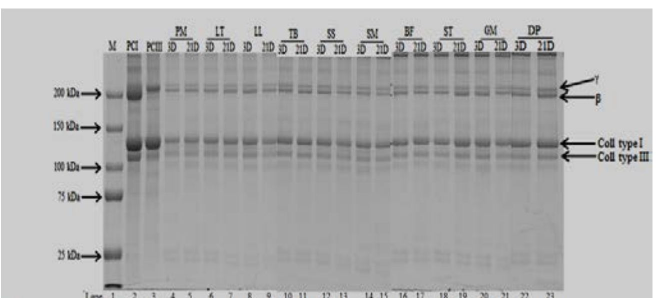

Figure 1 : Characterization of collagen by SDS-PAGE . Lane 1 Molecular weight marker, Lane 2: Pure Coll I, Lane-3: Pure Coll III, Lane 4: PM-3D, Lane 5: PM-21D, Lane 6: LT-3D, Lane 7: LT-21D, Lane 8: LL-3D, lane 9: TB-3D, Lane 10: TB-21D, Lane 11: SS-3D, Lane 12: SS-21D, Lane 13:SS-21D, Lane 14: SM-3D, Lane 15: SM-21D, Lane 16: BF-3D, Lane 17: BF-21D, Lane 18:ST-3D, Lane 19: ST-21D, Lane 20: GM-3D, Lane 21: GM-21D, Lane 22:DP-3d, Lane23: DP-21D.

IV. CONCLUSION

Muscle types have a significant effect on collagen content, collagen types and ratio and type I and type III collagen ratio have been extensively used for tenderness differentiation of beef.

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