# MECHANICAL CHARACTERISTICS OF BEEF AS A FUNCTION OF AGE (HEIFER VS. COW), AND POSTMORTEM AGING

Ch.Ochirbat[1], D.Dashdorj[1,2], M.N.Uddin[1], D.Aguayo[1], J.S.Lee[1], Duhak Yoo[3] and I.H.Hwang[1*]

[1]Department of Animal Science, Chonbuk National University, Jeonju 561-756, Republic of Korea

[2]Department of Livestock Production & Monitoring and Inspection, Mongolian University of Life Sciences, Mongolia

[3] Department of Animal Science, Kyungpook National University, Daegu 41566, Republic of Korea
[*]Corresponding author email:inho.hwang@jbnu.ac.kr

**Abstract – Texture and mechanical characteristics as a function of age (heifer vs. cow) and postmortem aging (3d vs. 14d) were evaluated for *longissimus dorsi* muscle of Hanwoo beef. Total collagen (P<0.05), tensile maximum force (P<0.05) and collagen types content (P<0.001) were greater in cow meat than in heifer meat. The WBSF, all tensile testing parameters and type III collagen content decreased (P<0.001) during 14 d aging.**

**The results indicate that an aging apparently had more influences on WBSF and tensile testing, while variations in TPA parameters could be mostly attributed to fat content.**

Key Words – Collagen characteristics, Hanwoo beef, TPA, WBSF

## I. INTRODUCTION

Meat texture is one of the most important attribute affecting its quality and consumer acceptability. The texture and mechanical characteristics of meat are influenced by connective tissue, myofibrils, fat, water and pH etc. and their interactions. There is a complex interplay between the breed, age, sex of the animal, muscle type etc. In addition, objective shear force measured by the Warner-Bratzler method does not relate to mechanical properties associated with chewing meat. While the principal of cyclical TPA is simulate chewing and obtain more objective information about textural properties. The mechanical characteristics are subdivided into the primary parameters of hardness, cohesiveness, elasticity, adhesiveness and into the secondary parameters of chewiness and gumminess. The tensile test is best suited for structural investigations and very different from those in compression. Thus these mechanical methods are may useful test in conjunction [1, 2]. However, limited scientific studies have examined the mechanical properties in relation to the age and carcass quality characteristics of Hanwoo beef. Three experiments WBSF, tensile testing and texture profile analysis were conducted on LD muscle to correlate the collagen characteristics of beef with its textural properties.

## II. MATERIALS AND METHODS

The *longissimus dorsi* muscle of Hanwoo heifers of age 28-36 mon (n=10) and cow of age 38-60 mon (n=10) were aged 4ºC for 3 and 14 days.

The total and heat soluble collagen content was determined using modified colorimetric method of Kolar [3]. Collagen extraction was performed by the methods of Muralidharan et al., [4] and SDS-PAGE was performed according to the method of Laemmli [5] with a slight modification. The image of SDS-PAGE gel was taken by the Versadoc Imaging system model 3000 Bio–Rad with Quantity One software. The densitometry for collagen protein specific bands was done in Gel Documentation System (Alpha Innotech, USA).

Texture measurements; All textural measurements were done on an Instron Universal Testing Machine (Model 3342, USA) using shearing, stretching and compression devices. The WBSF evaluated on six pieces core samples with 0.5 inch diameter. Samples sheared at a crosshead speed of 400 mm/min, using a 40 kgf load cell. Tensile testing was conducted on six strips cut in a rectangular bar shape with 70 mm long, 10 mm wide and 10 mm thick per sample. Stretching was performed at 50 mm/min. TPA was done on 3 cuts in a rectangular trapezoid shape with shallow end 0.5mm, deep end 1.5mm, 70 mm long and 60 cm wide per sample under 2 cycles of 60% compression at constant speed 50 mm/min. Data were analyzed using the GLM procedure and Duncan's multiple range test of SAS Version 9.3 (SAS Institute, Cary, NC, USA).

## III. RESULTS AND DISCUSSION

The age did not have its influence on in collagen solubility and mechanical characteristics, while increasing contents of total collagen (P<0.05), tensile maximum force (P<0.05) and collagen types content (P<0.001) connected to the increasing of age (P<0.05). Kurose et al., (2006) reported that the mechanical properties of the intramuscular connective tissue such as the ability resist tension, compression and extension, depend on nature and proportion of connective tissue components, also the size and distribution of its fibres. The intramolecular packing within fibrils makes a considerable contribution to the tensile properties of a tissue.

Postmortem aging resulted in decrease WBSF, all tensile testing parameters and type III collagen content (P<0.001). The breaking strength of the perimysial connective tissue in raw beef decreases during postmortem aging (Astruc 2014). Collagen and mechanical characteristics of TPA was not affected by postmortem aging.

Table 1. Collagen, texture and mechanical characteristics of *longissimus dorsi* muscle from Hanwoo beef subjected to different age and post-mortem aging

| Traits | Age | | Aging | | SEM | F value | |
|---|---|---|---|---|---|---|---|
| | Heifer | Cow | 3d | 14d | | Age | Aging |
| Total collagen, g/100g | $0.22^{b}$ | $0.28^{a}$ | 0.25 | 0.25 | 0.02 | 3.53* | 0.07 |
| Soluble collagen, g/100g | 0.11 | 0.12 | 0.11 | 0.12 | 0.01 | 0.83 | 0.13 |
| Type I collagen | $10.9^{b}$ | $12.0^{a}$ | $11.4^{b}$ | $12.9^{a}$ | 0.07 | $110^{***}$ | $66^{***}$ |
| Type III collagen | $2.81^{b}$ | $2.96^{a}$ | $2.89^{a}$ | $2.56^{b}$ | 0.02 | $40^{***}$ | $103^{***}$ |
| Ratio (I/III) | $3.87^{b}$ | $4.03^{a}$ | $3.95^{b}$ | $5.06^{a}$ | 0.03 | $17^{***}$ | $551^{***}$ |
| WBSF, N | 3.84 | 4.33 | $4.07^{a}$ | 2.8b | 0.32 | 1.08 | $19.2^{***}$ |
| Tensile max. force, N | $2.61^{b}$ | $3.41^{a}$ | $2.99^{a}$ | $1.51^{b}$ | 0.26 | $4.38^{*}$ | $35.8^{***}$ |
| Tensile strain, % | 147 | 180 | $163^{a}$ | 74b | 22.5 | 0.98 | $27.5^{***}$ |
| Tensile extension, mm | 14.9 | 18.1 | $16.4^{a}$ | $7.47^{b}$ | 2.25 | 0.99 | $27.6^{***}$ |
| Hardness, N | 46.9 | 50.2 | 48.5 | 45.6 | 3.06 | 0.52 | 0.76 |
| Springiness, mm | 1.05 | 1.10 | 1.07 | 1.01 | 0.06 | 0.35 | 0.81 |
| Gumminess, N | 0.01 | 0.03 | 0.02 | 0.01 | 0.04 | 0.10 | 0.18 |
| Adhesiveness, J | -0.01 | -0.01 | -0.01 | -0.01 | 0.00 | 0.63 | 0.97 |
| Chewiness, N*mm | 0.09 | 0.14 | 0.11 | 0.09 | 0.05 | 0.49 | 0.28 |

$^{a\text{-}b,}$ means within raw with different superscripts are significantly different; $^{***}$ P<0.001, $^{**}$ P<0.01, $^{*}$ P<0.05

## IV. CONCLUSION

Postmortem aging evaluated had no effect on mechanical characteristics or TPA. The collagen types probably make a considerable contribution to the tensile properties of a tissue. The results indicate that an aging apparently had more influences on WBSF and tensile testing than on TPA measurement. These variations in the aging may cause changes in the muscle microstructure, generating products with a more disorganized structure.

## ACKNOWLEDGEMENTS

It should be acknowledged that this work was carried out with the support of Next-Generation BioGreen 21 Program (Project PJ011102), RDA, Republic of Korea.

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