The impact of intramuscular fat grade and aging on consumers' evaluation of beef tenderness

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I. INTRODUCTION

Consumers evaluate overall satisfaction when consuming beef, considering tenderness, flavor, and juiciness, among other factors. Among these, tenderness is known to have the most significant impact [1-3]. For general consumers or untrained panels, the evaluation of beef taste/satisfaction is influenced by societal culture and previous experiences [4]. For example, Korean and Japanese consumers prefer tender beef with fine marbling, while European consumers prefer beef with less marbling for health reasons [5,6]. The tenderness of beef is determined by various mechanisms, both inherent and acquired, such as muscle fiber density, characteristics of connective tissue, level and distribution of marbling, post-slaughter processing, and aging [7]. Shear force is a common method for mechanically measuring the tenderness of meat [8]. Although shear force, a physical measurement of meat texture, does not fully represent the tenderness perceived by consumers [9], consumers typically classify beef with shear force <4.37 kg as tender and >5.37 kg as tough [10]. The study was conducted among South Korean consumers to compare the impact of intramuscular fat level and aging on tenderness evaluation.

II. MATERIALS AND METHODS

From 2007 to 2020, data on Hanwoo beef analyzed at Jeonbuk National University and the National Institute of Animal Science were collected. The analysis results for the Longissimus thoracis (LT) muscle from a total of 90 heads (7 bulls, 19 cows, 10 heifers and 57 steers) generated across four projects were utilized. All animals were conventionally raised in feedlots and slaughtered according to the regulations set forth by the Korea Animal Plant Quarantine Agency of the Ministry of Agriculture, Food and Rural Affairs for beef slaughter at commercial abattoirs. And then immediately moved to a chilling room and stored at 4 °C, after 24 h in the chilling room, all carcasses were graded according to the Korean Beef Carcass Grading System included intramuscular fat grade [11]. Aging was initiated 24 hours post-slaughter, designated as Day 0 of aging. The shear force and sensory-tenderness evaluation methods used in the analysis were consistent across all projects. The methods used were as follows: Shear force measurements were conducted using a Warner-Bratzler blade. Meat blocks were heated in a water bath until the core temperature reached 70°C, then cooled in running water for 30 minutes. Cores(1.25cm) parallel to muscle fibers were took, and shear force was measured using an Instron Universal Testing Machine (Model 3342; Instron Corporation, Norwood, MA, USA) For sensory evaluation of tenderness, a 100mm line scale method was used, with the item scale ranging from very tough (0) to very tender (100). The data from samples with shear force values ranging between 3-5 kg out of the collected data were utilized for statistical processing. The statistical analysis was conducted using IBM SPSS Statistics (version 27.0, SPSS Inc., Chicago, IL, USA). The comparison of the impact of intramuscular fat level and aging on tenderness was conducted using multiple regression analysis.

III. RESULTS AND DISCUSSION

To explore how intramuscular fat grade and aging in the LT muscle of Hanwoo affect tenderness evaluations by Korean general consumers, a multiple linear regression analysis was conducted, and

the results are shown in Table 1. The analysis revealed F=21.996 (p<0.001), indicating the suitability of the regression model, with an Adj.R^2 of 0.300, explaining 30% of the variance. The results from shear force measurements, a mechanical quantification of meat tenderness in the LT muscle of Hanwoo with shear force values between 3-5 kg, showed that intramuscular fat grade had a significant impact on tenderness evaluations with β=0.500 (p<0.001). Similarly, aging also had a statistically significant impact on tenderness evaluations with β=0.332 (p<0.001). These results suggest that for intramuscular fat level, with β=3.311 (p<0.001), for each unit increase in intramuscular fat level, tenderness increased by 3.311 points. And for aging, with β=0.913 (p<0.001), for each day of aging, tenderness increased by 0.913 points. The relative impact of intramuscular fat grade and aging on consumer tenderness evaluations was compared through the standardized coefficients β values. The standardized coefficients β values for intramuscular fat level and aging were 0.500 (p<0.001) and 0.332 (p<0.001), respectively, indicating that intramuscular fat grade has a relatively higher impact on tenderness evaluations compared to aging.

Table 1 – Comparison of the Impact of Intramuscular Fat Level and Aging on Consumer Sensory-Tenderness Evaluation in the Longissimus Thoracis Muscle of Hanwoo (Shear Force 3-5 kg).

Variations	Unstandardized coefficient		standardization coefficient	t(p)	TOL	VIF
	β	SE	β			
(Coefficient)	3.918	3.417		12.851		
Intramuscular-fat grade	3.311	0.565	0.500	5.864[***]	0.981	1.020
Aging days	0.913	0.235	0.332	3.887[***]	0.981	1.020
F(p)			21.996[***]			
Adj.R^2			0.300			
Durbin-Watwon			1.975			

[***]P<0.001

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