ASSESSMENT OF CHEMICAL COMPONENTS AND PORK QUALITY TRAITS OF THE 13 PORCINE MUSCLES

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Abstract – To investigate muscle characteristics related to chemical composition and meat quality traits of the 13 major muscles from pork carcass, 15 pork carcasses were selected randomly from 5 carcasses × 3 quality grades (1+, 1, 2 grades), and the 13 muscles including *Psoas major* (PM), *Longissimus dorsi* (LD), *Spinalis cervicis* (SC), *Supraspinatus* (SU), *Triceps brachii* (TB), *Biceps femoris* (BF), *Semimembranosus* (SM), *Semitendinosus* (ST), *Gluteus medius* (GM), *Triceps surae* (TS), *External abdominal oblique* (EO), *Serratus ventralis* (SV), and *Diaphragm* (DA) were separated from right side of each carcass. The highest percentage of fat and protein were observed in SV and EO whereas BF and SM showed the lowest percentage of fat (P<0.05). SM had the highest percentage of moisture while the lowest moisture percentage was observed in EO. PM and DA had the highest value of CIE a* while the lowest value was observed in LD (P<0.05). The highest drip loss was observed in PM while SM` showed the highest cooking loss (P<0.05). The highest value of shear force was observed in GM while PM had the longest sarcomere length (P<0.05). Moisture was correlated with cooking loss (P<0.05) whereas protein was not significantly correlated with drip loss, cooking loss and shear force (P>0.05). Fat content was negatively correlated with cooking loss (P<0.01) while CIE a*, sarcomere length and oleic acid percentage were not correlated with all quality traits (P<0.01). Also, Fat content was strongly related to all sensory palatability attributes (P<0.001). Results implied that the most important pork quality trait for sensory palatability is fat content in porcine muscles.

Key Words – Porcine muscles, Pork muscle characteristics, pork quality.

I. INTRODUCTION

Pork is the main animal food resources in Korea, providing many admirable nutrients including essential amino acids, unsaturated fatty acids, minerals and vitamins. The annual per capita consumption of pork has been increased from 11.8 kg in 1990 to 20.9 in 2013. As increasing of pork consumption, the Korean pork industry is showing changes in trends toward marketing individual muscle cuts recently. The nutritional composition and meat quality traits differ by individual porcine muscles, which affects palatability characteristics. In general, Korean consumer prefer belly and rib cuts over loin or tenderloin because of higher fat content. However, the characteristics of individual muscles in relation to chemical components, meat quality traits and palatability are not well known, although the cooking and chemical attributes of the major beef muscles from beef carcasses were evaluated (Jeremiah et al., 2003; Jung et al., 2015; 2016).

Muscles in a pork carcass are composed of different muscle fiber types which are affected by various factors including gender, age, diet, muscle location, exercise etc. (Joo et al., 2013). Because muscle fiber characteristics influence pork quality characteristics, overall palatability also could be affected by individual porcine muscles. In this regard, it is important to understand the relationship between chemical components, meat quality traits and palatability attributes, and there is a need to characterize the individual porcine muscles. Therefore, total of 13 major porcine muscles were investigated in this study.

II. MATERIALS AND METHODS

Fifteen pork carcasses (5 carcasses × 3 grades) were selected randomly from a commercial slaughterhouse at 24 h postmortem, and thirteen muscles were separated from right side of each carcass. Muscles were transported to laboratory for measuring chemical components, pork quality traits and palatability attributes. The 13 porcine muscles sampled and Korean name of retail pork cuts are shown in Table 1.

Table 1 Muscles sampled and retail pork cuts in Korean

Major muscles	Nomen-clature	Retail pork cuts Name in Korean
Psoas major	PM	Ansimsal
Longissimus dorsi	LD	Dungsimsal
Spinalis cervicis	SC	Moksimsal
Supraspinatus	SS	Abdarisal
Triceps brachii	TB	Absatae
Biceps femoris	BF	Bolgitsal
Semimembranosus	SM	Sulgitsal
Semitendinosus	ST	Hongdukesal
Gluteus medius	GM	Bosupsal
Triceps surae	TS	Duitsatae
External abdominal oblique	EO	Samkyupsal
Diaphragm	DA	Kalmaekisal
Serratus ventralis	SV	Kalbisal

Percentages of moisture, protein and ash were determined according to AOAC (2000). The crude fat was extracted by the method of Folch et al. (1957) and fatty acid composition was analyzed by gas chromatography as described by Jung et al. (2006). Drip loss (%) was determined by suspending muscle samples standardized for surface area in an inflated plastic box for 24 h at 4℃. The meat color (CIE Lab) was measured on the surface of muscles using a Minolta Chromameter CR-300 that was standardized with a white plate (Y=93.5, X=0.3132, y=0.3198). Warner-Bratzler shear force (WBSF) values were determined using an Instron Universal Testing Machine. Samples were 1.3 cm diameter cores obtained from steaks cooked to 70℃ internal temperature for 30 min. Sarcomere length was determined by the method of cross et al. (1981).

Muscle samples were evaluated by an 8 member trained expert descriptive attribute sensory panel in Meat Science Laboratory at Gyeongsang National University. Panelists evaluated flavor, tenderness, juiciness, chewiness and overall palatability with cooked meat using a 9-point hedonic scale as described by Meilgaad et al. (1999).

Data from three replications were analyzed by analysis of variance (ANOVA) using statistical analysis systems (SAS, 2002). ANOVA was adopted to design the mathematical model using SAS 9.2. Duncan’s multiple range tests were used to determine significance among means. Statistical significance was considered when P value was less than 0.05. Also, regression analysis was used to generate Pearson correlation coefficients between muscle measurements and sensory panel scores.

III. RESULTS AND DISCUSSION

The highest percentage of protein and fat were observed in LD and SV muscles whereas SV muscle showed the lowest percentage of protein (Table 2). (The standard deviation and statistical significances are not shown). The lowest percentage of fat was observed in BF and SM muscles (5.7%). SM and BF muscles had the highest percentage of moisture while the lowest moisture percentage was observed in EO muscle. EO muscle also showed higher percentage of fat, and SV muscle also had lower percentage of moisture. Results indicated that moisture percentage might be negatively correlated with the percentage of fat, but positively correlated with protein content.

Table 2 Mean values for percentage chemical moisture, protein, fat and ash of muscles from pork carcass

Muscles	Chemical components (%)			
	Moisture	Protein	Fat	Ash
PM	70.3	20.0	7.3	2.3
LD	69.4	22.4	6.0	2.1
SC	66.5	18.4	13.5	1.6
SS	69.3	21.3	7.5	1.9
TB	72.7	20.3	4.9	1.9
BF	71.4	20.1	5.7	2.4
SM	71.7	20.8	5.7	1.8
ST	67.9	20.3	9.9	1.8
GM	68.8	18.2	10.7	2.2
TS	70.8	19.7	7.1	2.4
EO	58.4	21.5	18.8	1.3
DA	63.1	18.1	15.8	2.5
SV	59.1	17.7	21.6	1.4

PM and DA muscles had the highest CIE a* value while LD muscle showed the lowest redness value (Table 3). PM muscle showed the highest drip loss (%) whereas the lowest drip loss (%) was observed in EO muscle. The highest cooking loss (38.2%) was observed in SM muscle while GM muscle had the lowest cooking loss (18.6%). GM muscle showed the highest WBSF value while the lowest WBSF value was observed in DA muscle. The DA muscle had the shortest sarcomere length and the longest sarcomere length were observed in PM muscle. These results were unexpected because PM muscle showed higher WBSF value compared to DA muscle. The highest CIE a* value of PM and DA muscles suggest that both muscles had more red muscle fiber than others. Therefore, variations in sarcomere length and WBSF between PM and DA muscles are exactly unexplained. Results implied that tenderness of pork muscles may be not closely correlated with sarcomere length due to their complexity of muscle fiber compare to bovine muscles.

Table 3 Mean values for CIE a*, drip loss (%), WBSF and sarcomere length of muscles from pork carcass

Muscles	CIE a*	Drip loss	Cook loss	WBSF	Sarcomere length
PM	17.5	2.34	33.8	3.17	2.68
LD	6.7	1.87	32.2	3.26	2.19
SC	15.4	2.00	36.3	3.83	2.24
SS	13.1	1.86	37.6	4.44	2.14
TB	15.3	1.66	35.8	3.34	2.00
BF	7.5	1.99	33.3	2.99	2.12
SM	9.9	1.97	38.2	4.33	1.98
ST	12.8	1.92	36.6	4.10	2.20
GM	8.1	1.52	29.2	4.58	2.02
TS	13.0	1.57	32.1	2.93	2.23
EO	12.7	1.02	18.6	3.22	2.01
DA	17.1	2.26	33.7	2.61	1.95
SV	9.9	1.25	31.1	3.87	2.04

PM and DA muscles had the lowest oleic acid percentage while the highest percentage of oleic acid was observed in SM muscle (Table 4). Also, PM muscle had the highest unsaturated fatty acid percentage although the lowest percentage of monounsaturated fatty acid was observed in PM among 13 porcine muscles. SM muscle had the lowest percentage of polyunsaturated fatty acid and saturated fatty acids. DA muscle showed the highest percentage of saturated fat acids. Results suggest that PM and SM muscles are good source for PUFA and MUFA, respectively. Also, data suggest that SM muscle has better palatability due to higher oleic acid percentage.

Table 4 Mean values for percentage of fatty acids in 13 major muscles from pork carcass

Muscles	Oleic acid	SFA	MUFA	PUFA
PM	41.6	38.8	41.9	19.3
LD	46.5	37.7	46.7	15.7
SC	45.1	38.4	45.0	16.5
SS	46.9	36.9	46.9	16.2
TB	48.1	35.9	48.3	15.7
BF	44.5	37.8	44.7	17.5
SM	49.6	35.6	49.7	14.7
ST	48.1	36.4	48.1	15.4
GM	46.8	35.9	46.8	17.2
TS	48.1	35.3	48.3	16.4
EO	46.8	37.2	46.8	16.0
DA	42.3	41.2	42.3	16.4
SV	46.8	36.8	46.8	16.3

Correlation coefficients between chemical components and meat quality traits are represented in Table 5. Moisture and fat content were significantly correlated with cooking loss ($P<0.05$), but not correlated with drip loss and WBSF ($P>0.05$). Protein content, sarcomere length and CIE a* value were not significantly correlated with drip loss, cooking loss and WBSF ($P>0.05$). Oleic acid percentage had significant correlation with drip loss ($P<0.05$), but there were no significant correlations between cooking loss, WBSF and oleic acid percentage ($P>0.05$). These results indicate that intramuscular fat content is the most important factor for cooking loss. Also data suggest that drip loss may be decreased with increasing of oleic acid percentage because of increasing of intramuscular fat content in porcine muscle.

Table 5 Correlation coefficients between chemical components and quality traits of pork muscles

	Drip loss	Cooking loss	WBSF[1]
Moisture (%)	0.20	0.52*	0.14
Protein (%)	-0.11	-0.04	-0.01

Fat (%)	-0.12	-0.45**	-0.09
CIE a*	0.28	0.16	-0.18
Sarcomere length	0.23	0.08	-0.16
Oleic acid	-0.36*	0.08	0.01

[1] WBSF (Warner-Bratzler Shear Force)
* P<0.05, ** P<0.01, *** P<0.001

Table 6 showed that correlation coefficients between chemical components and sensory panel scores. Both moisture and protein percentages were negatively correlated with juiciness (P<0.05) whereas percentage of fat was positively correlated with all palatability attributes (P<0.01). Especially, there were strong correlations between fat content and juiciness and overall palatability (0.61 and 0.58, respectively, P<0.001). CIE a* value, sarcomere length and oleic acid percentage were not significantly related to all palatability attributes (P<0.05).

Table 6 Correlation coefficients between sensory panel scores and measurements of porcine muscles

	Tenderness	Juiciness	Palatability
Moisture (%)	-0.23	-0.37*	0.14
Protein (%)	-0.24	-0.42*	-0.14
Fat (%)	0.46**	0.61***	0.58***
CIE a*	0.06	-0.07	0.15
Sarcomere length	0.11	-0.13	0.04
Oleic acid	0.02	0.28	0.16

* P<0.05, ** P<0.01, *** P<0.001

These results suggest that sensory palatability could be affected by intramuscular fat content compared to moisture or protein content in porcine muscles. Especially, correlations indicate that high intramuscular fat content in pork muscle influences overall palatability of Korean consumer due to better juiciness. Furthermore, results suggest that Korean consumers might evaluate retail pork cut as tender meat when its marbling content is higher. Data also indicates that palatability attributes of pork muscles are not affected by umami element such as oleic acid.

IV. CONCLUSION

Porcine muscles vary in chemical components and pork quality traits. Tenderness of pork muscles may be not closely correlated with sarcomere length. Intramuscular fat contents vary among 13 individual porcine muscles and related to cooking loss and sensory palatability attributes. Palatability of pork muscle is not affected by oleic acid percentage. The most important quality trait for sensory palatability is fat content in porcine muscles.

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