Variation of Muscle Quality Parameters within the *Longissimus* Muscle

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Summary and Implications

Results of this study indicate that significant variation exists for muscle quality traits within the *longissimus* muscle. It is important to follow a rigidly standardized protocol when obtaining samples for use in pork quality research. The decision on which section to use as an estimate of the composite is not as important as is procedure. Relationships among sections with composite values are high for most quality traits.

Introduction

Enhancements in muscle quality as well as quantity of muscle is essential for improved consumer acceptance of pork. Factors influencing pork quality must be addressed if pork demand is to be increased. Marked quantitative variation exists in the chemical and physical characteristics of the *longissimus* muscle among breeds or lines and sexes (Goodwin, 1994). Additionally, variation exists in the characteristics of different muscles within the same animal (McKeith et al., 1981; Jeremiah, 1982; and Sharma et al., 1987). A problem in utilizing single muscles in meat quality studies is the possible existence of extreme variability within a single muscle.

The purpose of this study was to evaluate possible quantitative differences in muscle quality parameters within the *longissimus* muscle of pigs.

Materials and Methods

Data utilized for this project were collected as a part of the 1995 Livestock Producers' Assistance Program (LPAP) Segregated Early Weaning test conducted at the Northeast Iowa Swine Improvement Association station located near New Hampton, Iowa. Pigs were weighed off-test on an individual basis at weekly intervals upon reaching a weight ≥ 250 lbs.

A single off-test group of 50 pigs from the LPAP test (21 gilts and 29 barrows) was utilized for this study.

Pigs were transported to the Hormel Co. in Austin, Minnesota for carcass evaluation upon completion of the test. After a two hour rapid chill, standard carcass collection procedures, as outlined in Procedures to Evaluate Market Hogs (NPPC, 1991, 3rd ed.), were followed. Additionally, carcass quality measures of pH, chemical pH, drip loss, lipid, Minolta Y, and Hunter L were taken.

A four rib (eighth to eleventh) section of the *longissimus* muscle was removed from the right side of each carcass, identified, and transported to the Iowa State University Meat Lab. The samples were individually bagged in plastic and kept refrigerated until processed approximately 24 hours later.

The four-rib *longissimus* section was trimmed of bone and fat and divided by rib-section. Carcass quality traits on the 10th rib section had previously been evaluated for the purpose of the LPAP test. Because of this, a fresh interface at the 10th rib was not available, therefore quality measurements taken at Hormel on the 10th rib section were utilized for this analysis. The 8th, 9th, and 11th rib sections were set out, uncovered, with the freshly cut surface up, to allow the sample to "bloom". Drip loss was measured on each of the three sections according to a modified procedure of Kauffman (1986) at approximately ten minutes after the freshly cut surface had been exposed to air. Color reflectance (Minolta Y and Hunter L) was measured using the Minolta Chromameter DP310 set to measure reflectance values. Measurement of pH was performed by inserting a surface electrode into the center of each of the three chops. All of the chops, including the 10th rib section, were ground in a high speed food processor and prepared for lipid extraction and an additional measure of pH. The samples were analyzed for lipid content according to the procedure of Bligh and Dyer (1959). The additional measure of pH (LpH) on each chop was performed on a sample of the ground *longissimus* muscle that was thoroughly blended with deionized, distilled water in a high speed homogenizer.

Data were analyzed using a least squares analysis of variance procedure according to a general linear model (SAS, 1985) to evaluate dependent sources of variation. The data were assessed as a split plot analysis. The model included the effects of sex, pig(sex), and rib location. Bonferroni T tests were performed to investigate differences between rib location within the *longissimus* muscle for muscle quality traits. Residual correlation coefficients were utilized to analyze relationships between the various muscle quality traits. Pearson product moment correlation coefficients were used to determine relationships for a single trait measured at the four locations.

Results and Discussion

Least squares means and standard errors for muscle quality traits across location are given in Table 1. Bonferroni T tests were utilized to evaluate differences between rib location within the longissimus muscle for muscle quality traits. Significant location differences ($P<0.05$) were found for all muscle quality traits. It is important to make note, however, that differences between the Minolta Y, Hunter L, pH, and drip loss traits evaluated on the 10th rib location and those at the 8th, 9th, and 11th rib locations are confounded by the period of time and/or location in which they were evaluated. Therefore, it is impossible to determine whether the differences observed are real position effects or attributable to the time in which the loin sections were evaluated. It is reasonable to suggest that

the differences observed in drip loss and pH are not due to position, but they are attributable to the period of time in which they were taken. This assumption is made, because there were no significant differences for these traits when evaluated at the other locations that were measured at the same time. It is also known that quantitative differences in drip loss and pH of pork *longissimus* muscle are affected by the time post-mortem at which they are evaluated (Offer and Trinick, 1983; Bendall and Swatland, 1988). The decrease in drip loss over time is expected, however higher pH observed at the 10th rib compared to the 8th, 9th, and 11th ribs is not as readily predicted. There are several possible explanations for this occurrence. One of the likely causes for this occurrence is the influence of temperature (Bendall and Swatland, 1988). This effect could be quantified in this study, because muscle temperatures were not recorded. The differences observed in Minolta Y and Hunter L values can be assumed at least partially due to position, because Minolta Y and Hunter L values declined progressively from the 8th to the 11th rib.

Pearson correlations are shown in Table 2. pH was negatively associated with drip loss ($P<0.01$), Minolta ($P<0.001$), and Hunter ($P<0.001$), indicating that samples with a low pH are likely to be paler in color and produce higher losses of exudate. Drip loss was positively associated with Minolta ($P<0.001$) and Hunter ($P<0.01$) values.

Residual correlations are given in Table 3. LpH and lipid correlations with all other variables are low. This suggests that the position effects are small, since the residual correlations are reflected on a within-animal basis. Residual correlations for drip loss, pH, Minolta Y, and Hunter L are low but significant ($P<.05$). Again, it is impossible to determine whether the differences observed are real position effects or attributable to the time in which the loin sections were evaluated. It is reasonable to suggest that the differences observed in drip loss and pH are not due to position, but they are attributable to the period of time in which they were taken. The differences observed in Minolta Y and Hunter L values can again be assumed at least partially due to position.

Tables 4 - 9 show Pearson product moment correlation coefficients for each muscle trait measured across the four locations. All traits, except drip loss, are highly correlated across the four locations.

Conclusions

The results of this study indicate that significant variation exists for muscle quality traits measured within the *longissimus* muscle. A standardized procedure should be developed and followed rigidly when processing samples in pork quality research. The analysis indicates that this standardization is seemingly more significant than the problem of which position to use as an estimate of the composite, because on a relative basis section values of the correlations are highly associated with those of the aggregate.

References

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Table 1. Means and tests of significance for muscle quality traits of the *longissimus* muscle within location.

	Variable					
	Lipid	Minolta Y	Hunter L	pH	LpH	Drip Loss
Location						
8th rib	2.321±.062[a]	21.95±.28[a]	46.70±.28[a]	5.944±.013[a]	5.776±.017[b]	0.3039±.0282[b]
9th rib	2.271±.058[a]	21.76±.26[ab]	46.65±.26[a]	5.954±.012[a]	5.842±.016[a]	0.2954±.0266[b]
10th rib	1.914±.059[b]	19.83±.27[c]	44.28±.27[c]	5.664±.013[b]	5.809±.016[ab]	0.4592±.0272[a]
11th rib	2.358±.058[a]	20.75±.29[bc]	45.40±.27[b]	5.931±.013[a]	5.827±.016[ab]	0.3380±.0272[b]

Means with the same letter are not significantly different (P<0.05)
[abc] Bonferroni T tests used for significance testing

Table 2. Pearson correlations among muscle quality traits of the *longissismus* muscle.

Variable	Minolta Y	Hunter L	pH	LpH	Lipid
Drip Loss	0.45*	0.44*	-0.46*	0.39*	0.03
Minolta		0.98*	-0.45*	-0.60*	0.32*
Hunter			-0.45*	-0.62*	0.31*
pH				0.68*	-0.05
LpH					-0.08
Lipid					

* P<0.001

Table 3. Residual correlations among muscle quality traits of the *longissismus* muscle.

Variable	Minolta Y	Hunter L	pH	LpH	Lipid
Drip Loss	0.31**	0.30*	-0.23*	0.11	0.05
Minolta		0.92**	-0.32**	0.10	-0.01
Hunter			-0.34**	0.09	-0.02
pH				-0.08	-0.02
LpH					0.01
Lipid					

* P<0.01
** P<0.001

Table 4. The relationships of lipid values measured at 8th, 9th, 10th, and 11th ribs of the *longissimus* muscle.

Location	9th rib	10th rib	11th rib
8th rib	0.87*	0.81*	0.84*
9th rib		0.81*	0.81*
10th rib			0.85*
11th rib			

* P<0.001

Table 5. The relationships of Minolta Y values measured at 8th, 9th, 10th, and 11th ribs of the *longissimus* muscle.

Location	9th rib	10th rib	11th rib
8th rib	0.81*	0.75*	0.68*
9th rib		0.67*	0.80*
10th rib			0.78*
11th rib			

* P<0.001

Table 6. The relationships of Hunter L values measured at 8th, 9th, 10th, and 11th ribs of the *longissimus* muscle.

Location	9th rib	10th rib	11th rib
8th rib	0.91*	0.75*	0.69*
9th rib		0.78*	0.84*
10th rib			0.77*
11th rib			

* P<0.001

Table 7. The relationships of pH values measured at 8th, 9th, 10th, and 11th ribs of the *longissimus* muscle.

Location	9th rib	10th rib	11th rib
8th rib	0.92*	0.82*	0.92*
9th rib		0.87*	0.92*
10th rib			0.79*
11th rib			

* P<0.001

Table 8. The relationships of LpH values measured at 8th, 9th, 10th, and 11th ribs of the *longissimus* muscle.

Location	9th rib	10th rib	11th rib
8th rib	0.79*	0.79*	0.77*
9th rib		0.77*	0.78*
10th rib			0.76*
11th rib			

* P<.001

Table 9. The relationships of drip loss values measured at 8th, 9th, 10th, and 11th ribs of the *longissimus* muscle.

Location	9th rib	10th rib	11th rib
8th rib	0.67*	0.46*	0.48*
9th rib		0.30*	0.55*
10th rib			0.24**
11th rib			

* P<0.001
** P<0.05